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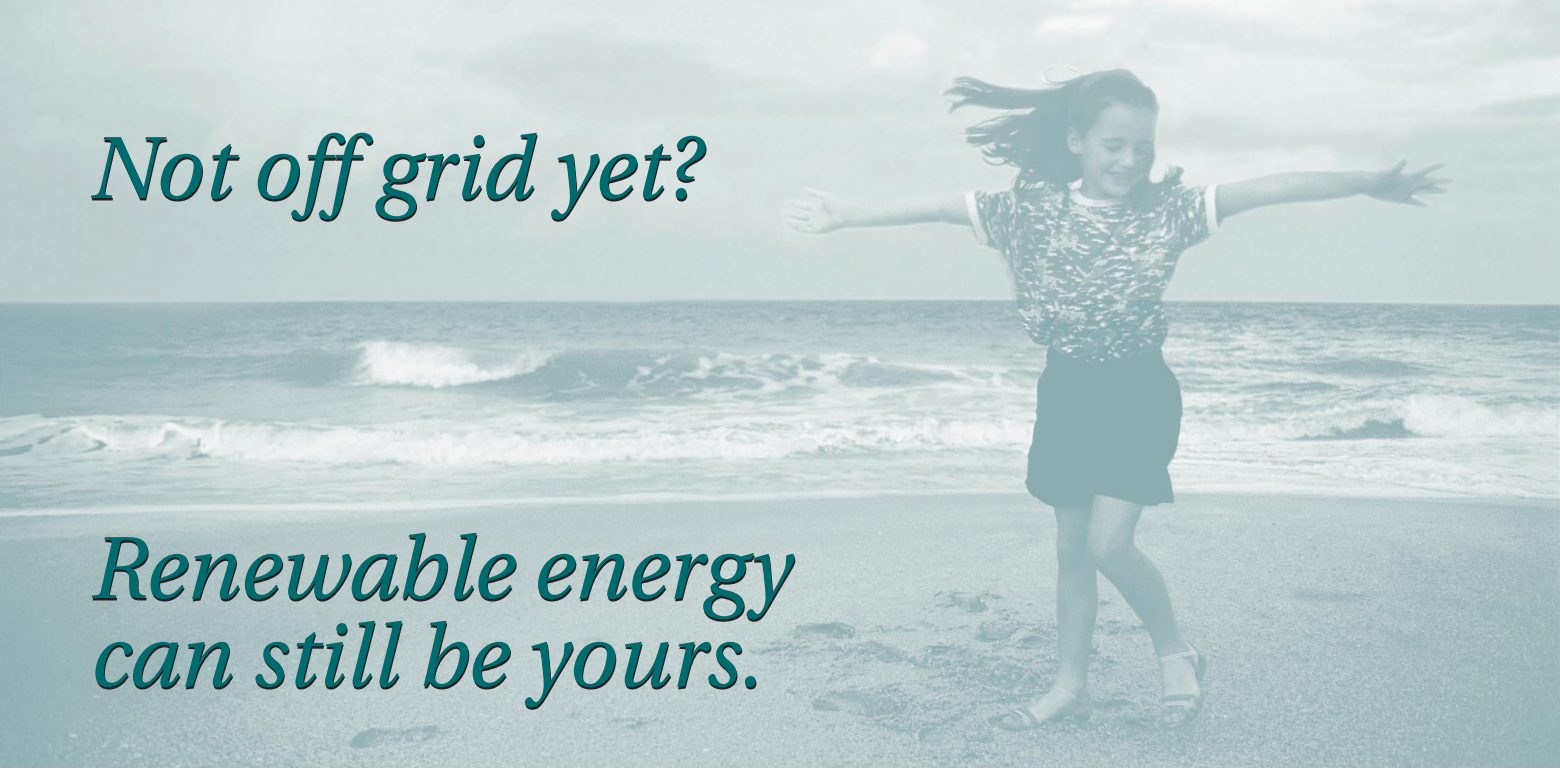

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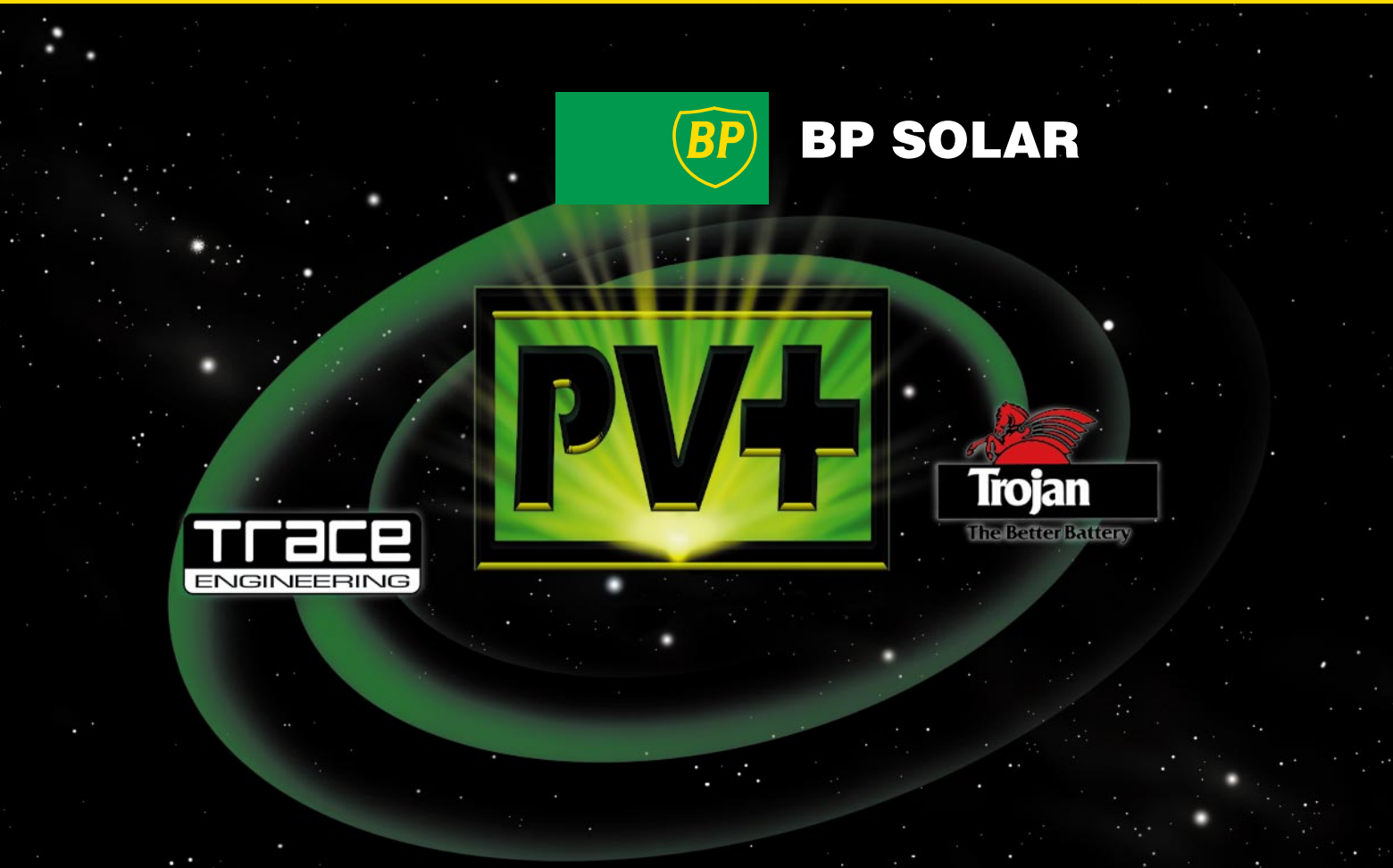

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HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

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Features

GoPower

GoPower

Features

Cover: Hodge-podge photo montage—great stuff happening in renewable energy.

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Columns

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Access and Info

Access Data

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Recycled Paper

Recyclable Paper

Above: Joy & Sacha, Arcata Renewable Energy Fair organizers, in an electric Porsche Speedster owned by Greg Williams of Six Rivers Solar.

We at *Home Power* look forward every year to the Midwest Renewable Energy Fair (MREF) as *the grand renewable energy event*. We get to schmooze with our colleagues in the industry (many of whom we see only there), and with the thousands of public attendees who are intrigued by the technology enough to travel to Wisconsin.

Last week, however, we attended a scaled-down version of MREF—a small, one-day fair in Arcata, California. Less than a dozen exhibitors, and a few workshops had an effect on Arcata that MREF couldn't have had. What did this fair have that MREF didn't? Well, it was local. Except for those living near Amherst, Wisconsin, MREF attracts only those already committed to renewable energy.

The Arcata fair brought the reality of renewable energy to yet one more community. This small fair gives us the ability to educate and inspire our neighbors, introducing new people to the concept of renewables. We get to be a little bit more technical with those who are already inspired, but not yet experienced. Young and old, liberal and conservative hung out at our booth in Arcata to get the "scoop". We also get to meet the real RE nerds who come out of the woodwork for such an event; you'd be surprised at the great projects your neighbors are up to. We get to discuss local variables and solutions. Weather, terrain, utility requirements, and building codes are all topics of interest. Basically, we get to spread the word to people who wouldn't be exposed to it otherwise. The local media jumps at the chance to cover something new and different. And, while all this has great cumulative effect, it just feels good to focus on our own neighborhoods.

As great as MREF is, and I think *everyone* should attend, I have discovered the value of the small-time show. Like the influence that garage bands have had on on the music scene, even a small energy fair can ultimately make a big change. Besides, they're fun! Joy Anderson organized the Arcata fair, although new to the RE scene, and did a great job. She encourages folks everywhere to just give it a shot. *Home Power* will help.

Benjamin Root, for the Home Power Crew
at Funky Mountain Institute (42°01'02"N • 122°23'19"W)

People

Joy Anderson
Mike Brown
Drake Chamberlin
Sam Coleman
Jim & Mary Collar
Paul Gipe
John Hermans
Anita Jarmin
Kathleen Jarschke-Schultze
Stan Krute
Don Kulha
William Lord
Don Loweburg
Karen Perez
Richard Perez
Shari Prange
Benjamin Root
Mick Sagrillo
Bob-O Schultze
Joe Schwartz
Josh & Kaia Tickell
Michael Welch
John Wiles
Dave Wilmeth
Myna Wilson

"Think about it…"

"A gentleman never complains about anything he is either unwilling or unable to do something about."

–Guillermo Alejandro Pérez Marquez

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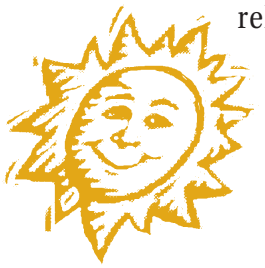

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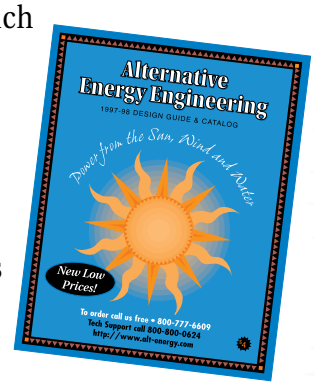

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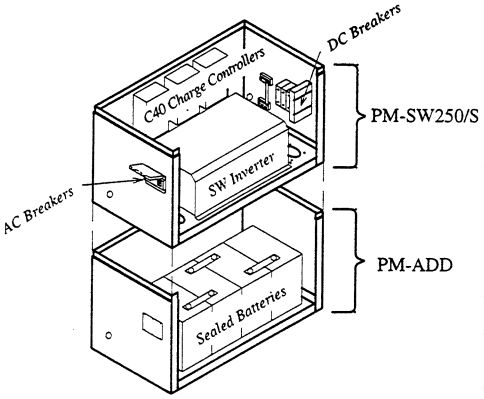

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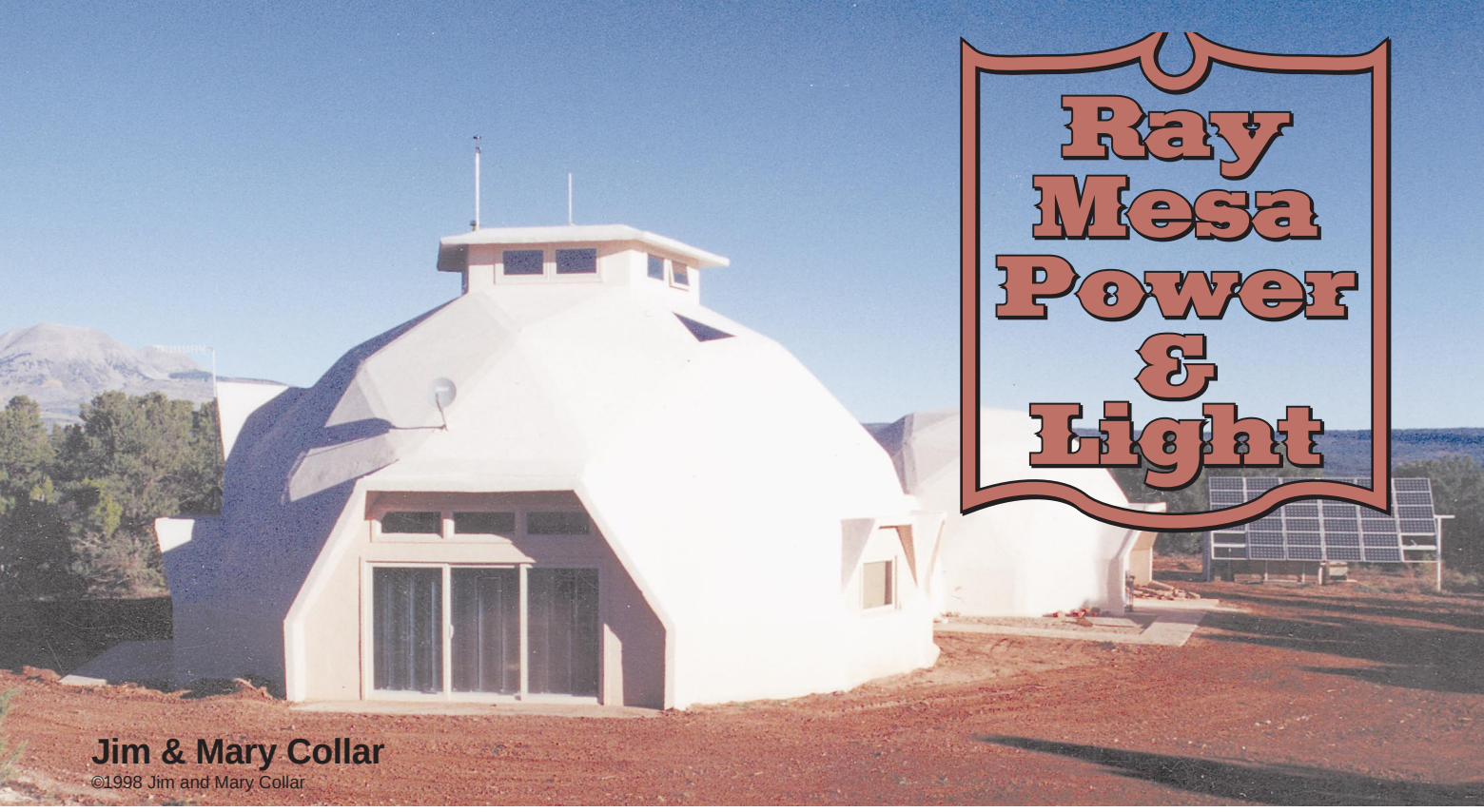


Ray Mesa Power & Light

Jim & Mary Collar

April Fools! It had to be the mother of all April Fools jokes. We were 40 miles from the nearest town of any size. The day before, we had been in our home of nearly 20 years in Salt Lake City, Utah. We had left 2000 square feet of suburban living space behind and now found ourselves standing at 7500 feet of elevation in the center of a small bulldozed clearing in the piñon and juniper forest. A slightly dilapidated 18 foot travel trailer sat off to one side. This was to be our home for the next eight months. Pavement and power lines were nearly two miles away. Our nearest full time neighbor was almost five miles distant, although at that moment it seemed like light years.

We stared intently at the fresh excavation, trying to envision what we were getting into, when my sixth sense kicked in. I ran to the trailer for a compass. Sure enough, the construction crew had neglected to consider magnetic declination when they excavated the foundation for our new home. The structure was over 15° off from true south! April Fools!

However, in spite of the situation (or perhaps because of it) we realized we were finally on the verge of fulfilling our dreams. We had worked and planned for this moment for years. We were excited and at the same time scared to death. And, as anyone who has built their own home can attest, the headaches and the work were only just beginning.

Dream House

The dream began in 1991 when we purchased 24 acres of virtual wilderness at a Utah state land auction. We figured that in about 20 years we might build a solar home for our retirement. However, as co-owner of a successful software consulting company, (all you really need to write software is a computer and phone) we decided to move the date up a little — like maybe 15 years! So in the space of three short years, we established a new corporate office in Moab, Utah, 40 miles from our building site. During this time, we designed our new home, including its solar power system.

In spite of our software business, my background is actually in mechanical engineering. Because of this, all aspects of the design process were carefully considered. Even in the sunny and arid desert climate of Moab (home to Arches and Canyonlands National Parks), 7500 feet of elevation means cold winter temperatures and plenty of snow, so we needed a well insulated and tightly constructed home. Given the surrounding forest and our mesa-top location, and since the nearest fire truck (and its volunteer fire department) was at least 10 miles distant, the danger of fire was a major concern. The answer surprised even me.

Above: View from the 2nd floor office down to the living room/dining room. Solar water tubes are visible on the right.

Mary had been researching everything she could find on alternative building materials and designs. She devoured articles and books about straw bale, rammed earth, poured adobe, earthships, log, and any other unconventional building systems. Finally, in early 1995, Mary announced she had found our house: a pre-cast concrete and styrofoam geodesic dome kit!

Dome-icile

The dome design is intrinsically strong (good snow and wind load capacity) and inherently energy efficient (the least exposed wall surface area for the most enclosed living space). The concrete shell would be virtually fire-proof. Nine inches of styrofoam cast and bonded to the concrete yielded R-36 walls and ceiling. What's more, it looked like it might be within our budget.

Although I wasn't wild about the look of a dome house, as an engineer I was excited about the sheer practicality. I quickly ran some heat loss calculations and found that at -20° F, we could expect to keep the 2700 square feet of living space at 70° F using little more than 30,000 btuh, about 1/3 the size of a conventional home furnace. With judicious use of a large solar window and a masonry heater fireplace (another of Mary's ideas), we could limit our use of propane for backup heating.

Below: The south windows allow the sun to heat the water tubes and thus the house, even during the harshest cold snaps.

Once we had the house selected we set about designing our floor plan. The manufacturer of the house, American Ingenuity of Rockville, Florida, provided a designer who worked with us to define our needs and translate them into construction drawings. The process lasted several months, required plenty of phone and fax, and cost us a few hundred dollars—money well spent.

Our custom floor plan stressed open spaces, for practical as well as aesthetic reasons. Open space promotes unrestricted air distribution for heating and cooling and reduces the need for conventional HVAC ducts and fans. Although our design included allowance for up to five direct vent propane wall heaters, we installed just two totaling 32,000 btuh (rated at sea level). Our 7500 foot altitude costs us dearly. High elevation and heat exchanger efficiency combine to reduce heat output by nearly 40% from rated capacity. Nevertheless, these losses are largely the result of our location, not the equipment, and are more than offset by the inherent efficiency of the super insulated dome.

Heat, Light, and Water

Although a dome does not particularly lend itself to passive solar design techniques (just what is the south side of a dome?) we worked hard to include over 80 square feet of south facing windows. We provided proper overhang to promote maximum solar heating in winter and negligible solar gain in summer. To capture and re-radiate the sun's heat over a longer period each day, we installed eleven 12 inch diameter by eight foot

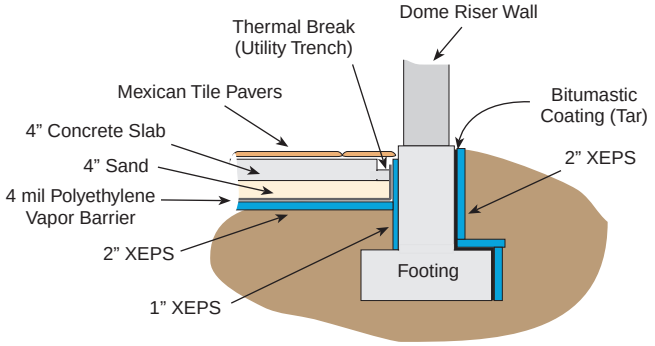
Above: Dome construction proceeds. When complete, the 2 by 4 framework comes down and is reused for inside framing.

high water tubes (over two tons of water!) immediately behind the solar window. We fabricated an insulated curtain which is lowered between the solar window and the water tubes at night.

In addition to the water tubes, thermal mass is provided by the four inch concrete slab which sits atop four inches of dry sand, a vapor barrier, two inches of foam insulation (XEPS), and is topped by heavy Mexican Saltillo tile pavers. All together, we have over 100 tons of thermal mass. Our slab design also includes a one inch "thermal break" or air gap between the outer perimeter of the slab and the inside walls of the foundation. This gap prevents heat loss from the warm slab to the top of the foundation, which is exposed to outdoor temperatures. Furthermore, the 36 inch deep foundation is insulated on the outside and the inside.

We selected double glazed, low-e (emissivity) vinyl windows for reduced heat loss and low maintenance. But even the most efficient windows can't match R-36 walls. It doesn't make much sense to punch heat-leaking holes in those thick walls. Nevertheless, judicious placement of windows resulted in a bright and well lit interior. The design included just one north facing window (actually a full view door onto the second floor deck). A mud room located in the link between the house and the garage helps reduce heat loss through the main entry door. All exterior doors include storm doors.

Foundation / Slab Detail



Our high desert mesa-top vantage point makes water a rare commodity. There are no producing wells in our immediate vicinity and our budget didn't permit us to gamble on a dry hole. So we decided to bury a 1500 gallon potable water tank and planned to haul water using our pickup truck. Accordingly, all appliances and fixtures were selected for low water usage. Although it was a major concern at first, we were pleased to find we use less than 35 gallons of water per day. Like many other worries, hauling water has turned out to be a minor issue requiring about three hours of effort each month. However, we may decide to take a gamble on that well in a year or two.

PV Design

Next, we tackled the solar power system. Shortly after we purchased the property, a representative from Utah Power & Light contacted us and "offered" to extend power lines to our lot for a mere $22,000. We laughed and decided that if we were to use this figure for our energy budget we'd end up with a premium system.

Early in the home design process, we decided that our dream of living in a wilderness setting didn't have to mean oil lighting and outdoor plumbing. Although we are both avid backpackers and backcountry enthusiasts, we make no apologies for our use of technology at work or home. We determined that our solar home would provide the same technological amenities we enjoyed in Salt Lake — but with far greater efficiency.

We subscribed to *Home Power* and devoured every issue cover to cover. We ordered books and product catalogs. I reviewed my library of engineering reference books. We surfed the net for solar sites. We studied weather patterns and even bought a home weather station. In short, we did our best to become renewable energy experts.

When we decided we were ready, we started with the conventional worksheet approach found in many solar

Above: The array of BP-75 modules with one more to install. Room for four more modules was good future planning.

energy books and catalogs, but the computer nerd in me quickly took over. To estimate loads, I developed a database program that permitted me to change lighting, appliances, and daily load distribution quickly and easily. I measured power consumption of our existing appliances and studied our usage patterns to generate realistic numbers.

I also developed a spreadsheet to automate the solar equipment sizing process and permit me to perform "what if" variations. We kept track of escalating costs using a series of construction take-off spreadsheets listing all materials and labor. This way we knew exactly how a Kohler generator affected the bottom line compared to a Honda. Hey, I'm a computer geek. What else can I say? The payoff was to come a year later.

Our location offers horizon to horizon solar exposure. Although no solar tables exist for our area, I extrapolated between Bryce Canyon, Utah (about 200 miles due west at the same elevation and latitude) and Grand Junction, Colorado (about 2500 feet lower and about 100 miles due north). Because we are close to the southeast flank of the second highest mountain in Utah, I made allowances for between three and up to five days of constant severe overcast. (With nearly two years behind us, I can say that this is a rare occurrence indeed.)

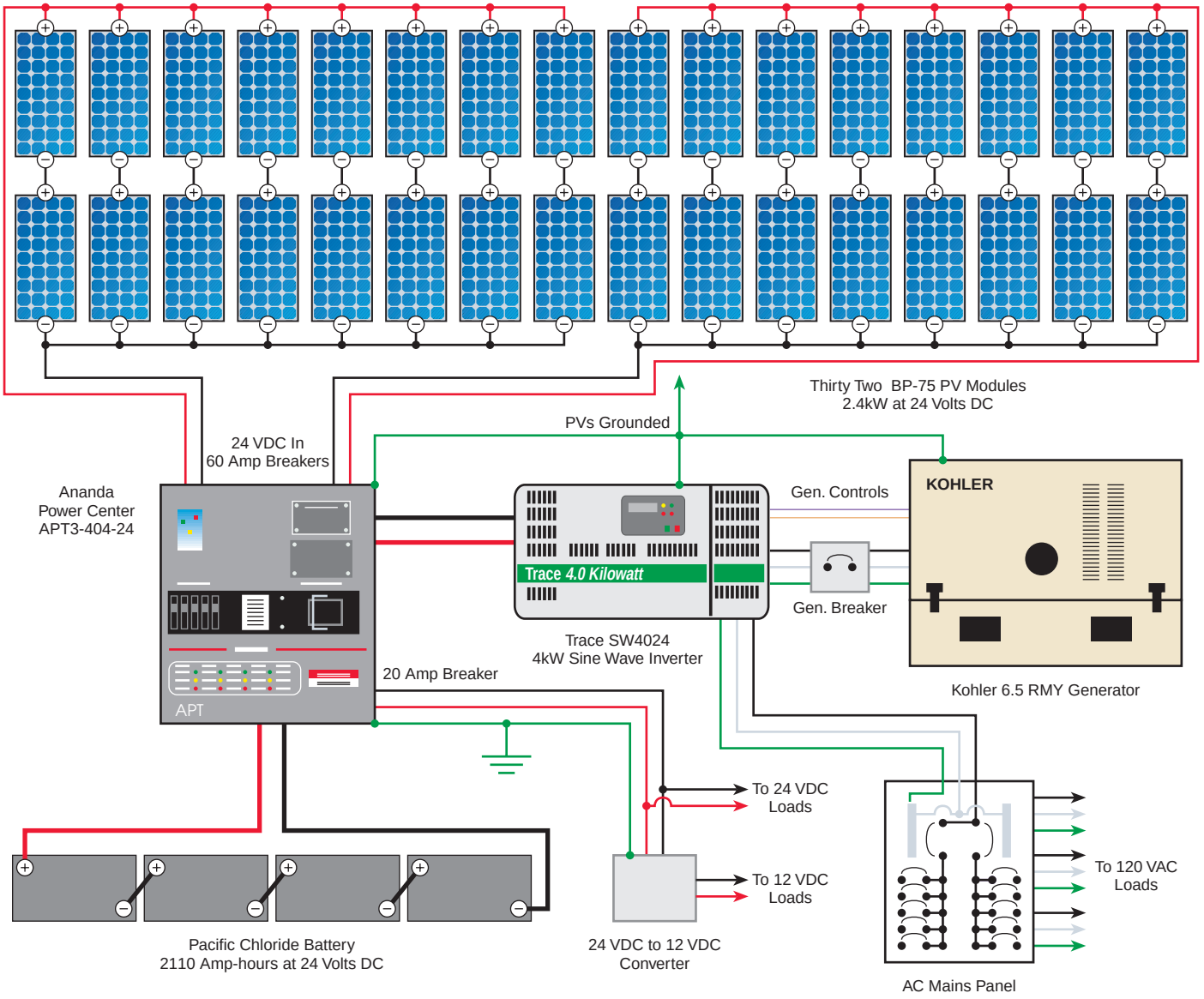
Our lighting design included compact fluorescents and halogens throughout the house. We included a Sun Frost 120 vac refrigerator, an Asko dishwasher, and a Staber washing machine as part of the RE power system. We bought the Staber and took delivery while we were still living in Salt Lake City so we could try it out — fabulous! We were convinced we were on the right track.

Finally, we selected a name: Ray Mesa Power and Light, named for one of the original settlers and for the geologic feature we would come to call home.

Buying Equipment

Based on our calculations and design, we were able to develop comprehensive written specifications for our RE system equipment. In some cases, we specified the required performance, i.e. "solar panels as required to provide minimum of 66 Amps at 24 VDC under the conditions outlined in the System Design Parameters." In others, we simply specified a make and model (for example, our Trace SW4024 inverter was a "given"). We decided to award the entire equipment order to the vendor who offered the best overall bid. The size of the order would enable us to negotiate the best deal (see sidebar, page 14.)

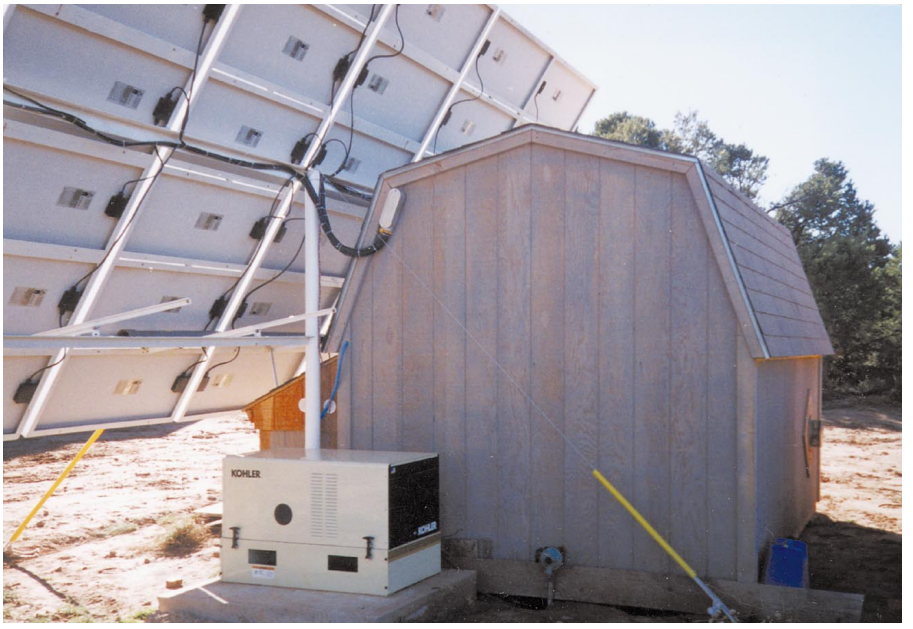
Below: Wrastlin' the big Pacific Chloride batteries into place. The box was built around them.



Specifications were sent to at least six qualified vendors selected largely from among *Home Power* advertisers. The bidding process took several weeks and included phone calls from and to most of the bidders to offer suggestions, solicit advice, and to ensure all vendors were bidding essentially the same quality equipment. After all the bids were received, evaluation took several weeks more as we short-listed to two companies and worked to refine their offerings. Although we saved well over 30% below the highest bid, cost was not our only criteria. We wanted to be certain we purchased from a knowledgeable and reputable supplier. Several companies met that criteria. All worked hard to get our business. In the end, we awarded the entire solar equipment order to Sierra Solar Systems of Nevada City, California. Jon Hill and his staff did an excellent job and were a pleasure to work with.

The final installed system represents a fairly conventional approach to PV power. Our PV array employs 32 BP-75 panels supplying an APT3 power center which charges our 2110 Amp-hour Pacific Chloride batteries. This is enough to last us three to five days, depending on usage. Given our ridge-top location, we included lightning protection in the APT. A Trace SW4024 sine wave inverter provides clean electrical power with no noticeable line noise. A backup generator is available if needed.

Since construction hadn't even begun when we awarded the solar equipment order, we took delivery over a period of several months. Shipping was timed to fit the construction schedule. The first item to be delivered was the Kohler propane-fueled backup generator. This unit provided all construction power and racked up over 700 hours in daily service during



Above: Back of the PV array, with battery box on south side of the solar power station. The Kohler propane generator is in the foreground.

construction. Since the solar electric system went on line in July 1996, the Kohler has run only for periodic testing.

Do It Yourself Construction

Each of triangular panels for the 45 foot diameter main dome weighs close to 350 pounds, more than we cared to tackle by ourselves. We contracted out the foundation and slab, erection of the two domes (house and garage), and the interior framing. Even with the extra help, acting as general contractor for a project in the middle of nowhere can be daunting and time consuming, to say the least. Few specialty contractors are willing to work at a site 40 miles from town without a considerable travel allowance. Since my full time job required a 50 hour work week to get our new Moab office up and running, we originally intended to contract the entire project. Our construction take-off spreadsheets quickly revealed the fallacy of that plan.

In order to keep the budget in check, Mary worked on the house as a full time general contractor: supervising, ordering, painting, laying tile, etc. I worked full time at the office weekdays until about six. We worked on the house together every evening and weekend . Along the way, we hired help when required to get the job done and learned new skills that allowed us to do much of our own work. Mary and I procured and delivered all materials, installed all of the plumbing and electrical wiring, painted, hung sheetrock, installed doors and trim, built the fireplace, installed all the tile, and gratefully accepted help from friends and family whenever offered. (And yes, we're still married.)

The initial PV design situated the inverter and batteries in the garage for ease of service and for winter warmth. By the time construction started, we elected to build a separate power house some 40 feet northeast of the garage. In addition to minimizing the hydrogen ventilation problem, this allowed us to run 120 vac circuits from the power house into the main distribution panel in the garage and reduced the distance we needed to run our 24 VDC main supply from nearly 80 feet to well under 20. A sturdy 8 by 12 foot storage shed served as our power house. A friend built an enclosed "dog house" battery compartment with inside access into the side of the shed to house our batteries. We insulated the entire shed and installed a small direct-vent propane heater to protect everything from sub-zero temperatures. Since the power station is nearly 100 feet away from the main house, we installed a Tri-Metric meter in the kitchen for remote system monitoring.

All wiring is installed according to the NEC. Doing the work ourselves allowed us to incorporate some special features to help reduce power consumption. We brought 24 VDC power from the APT power center to the house for limited use where we deemed it appropriate. Our Rocky Mountain Hydro ceiling fan and all under-counter halogen task lights (12 Volt lights wired in series pairs) utilize 24 VDC. All phantom loads are connected to switched outlets: the microwave, gas oven, stereo and video system, even the computers

Right: Building the custom PV rack.

Our Bidding Preference

The energy equipment bidding effort is time well spent. The key to success is to formalize the process to ensure that you can compare responses. Be sure all bidders have access to all the information they might require. You should also ask bidders to supply you with enough information to enable you to evaluate their offerings. If one supplier bids 20 Siemens 55 Watt panels and another bids 10 BP 75 Watt panels on a Wattsun Tracker, will you have enough information to evaluate the bids? We included data sheets with blank spaces for vendors to fill in key information for selected equipment. Bidders who neglected or declined to fill in the requested data were eliminated from consideration, regardless of their prices.

Be sure to treat bidders fairly. Don't give in to the temptation to give one vendor's prices to another to beat. After we had verbally awarded the order, the second place bidder offered to beat the low bid. We declined the offer and stood by our award. And although we might have saved even more if we had taken the bids and broken individual items out to the least expensive suppliers for each, we stuck by our word and awarded the entire order to a single vendor, even though we took delivery over a period of several months. Remember, getting a good price doesn't mean cheating the supplier. Ideally, both customer and vendor should win.

and printer. "Required" phantom loads such as the cordless telephone and answering machine and our amateur weather station were connected to a 24 to 12 VDC power supply from Zane International (Mike Gannon really stands behind his products). All clocks are battery powered except for the grandfather clock which uses something that will never run out — gravity. During the short days of winter, electrical consumption can be reduced to an absolute minimum and the inverter is often in search mode: pretty amazing for a 2700 square foot house chock full of appliances.

One advantage to living in the country is that you meet neighbors quickly. As word of "the weird dome house" spread, we were able to arrange for one of our new neighbors to construct and install a sturdy frame for our PV array at a good price and with no shipping charges. Our primary contractor donated several lengths of scrap 4 inch, schedule 40 pipe to serve as supports which we set in concrete four feet deep. We built six identical

Ray Mesa Power & Light System Costs

Quan	*Material*	*Cost*	*%*
32	BP-75 PV Panels	$12,000	42%
4	Pacific Chloride Batteries	$6,480	23%
1	Kohler 6.5RMY Generator	$4,600	16%
1	Trace 4024 Inverter	$2,700	9%
1	APT3-404-24 Power Center	$1,750	6%
1	PV Rack, custom built	$1,000	3%
	Misc: wire, conduit, etc.	$210	1%
	Total	$28,740	

racks, each capable of holding six BP-75 solar panels. We arranged our 32 panels in two 16 panel sub-arrays. We left space to add four more panels. (That's the engineer in me: whenever possible try to design for future expansion.) Given the fact that our biggest demand occurs in winter, we eliminated solar trackers for our PV array. With heavy snowfalls and temperatures as low as -20° F, we decided we just didn't need the extra moving parts. And, at our latitude, a tracker adds only about 10% efficiency in winter months which is not enough payback in saved PV panels. Our home-built racks are adjustable for winter and summer positions and can be adjusted by one person in less than 30 minutes. We snugged the power house in under the solar array.

We installed the PV panels on the racks and wired them to junction boxes in the power house. There, we installed the APT load center, the Trace SW4024 inverter, and the batteries. The moment of truth was at hand. The Trace inverter manual includes warnings of dire consequences if polarity is inadvertently reversed. I checked polarity. Then I re-checked it. And checked it again. In spite of my engineering background, I was sweating far more than that July day dictated. Finally, I plugged the main disconnect into the APT Power Center and held my breath. The inverter hummed and came to life. Power! We had power! 120 vac from the sun! I turned on a single bare incandescent light bulb and just stood there and admired it.

Results

Well, it's been over two years since that April Fools Day. In fact, it's been almost two years since that day in July, and although we moved into our house in January of 1997, we are still working on it. The solar water tubes are installed in the south facing solar window, and we have completed installation of the chimney for the masonry heater fireplace, another success story. Next summer we'll add rock facing to finish off the fireplace. And of course there are a myriad of less urgent tasks to keep us busy for the foreseeable future.

Since that day in July 1996, our house and solar electric system have met and exceeded all of our expectations. Our home is warm and spacious. Even with nighttime temperatures below zero, a fire in the masonry heater in the evening and a full day of sun warms the house to 70° F. The exterior is virtually fire-proof — a point brought into sharp focus by a summer forest fire which raged to within 1/2 mile of our home before being brought under control by several fire fighting crews and numerous retardant bombing runs by airborne firefighters. Although not needed, the availability of 1500 gallons of stored water proved to be an asset.

Engineering instincts, attention to detail, and all those computer simulations (fancy words for doing lots of "what if" calculations) resulted in a house and an electrical system that will serve us well. Our average summertime power consumption is between 150 and 200 kWh/month for 2700 square feet of living space. Wintertime consumption is somewhat higher. For comparison, our average pre-solar usage was near 600 kWh/month in our 2000 square foot suburban home! We enjoy all the technological amenities yet have endeavored to minimize our impact on our surroundings. We are pleased to say we have found almost nothing that we would have done differently.

Take that, Utah Power & Light!

Access
Authors: Jim & Mary Collar (Ray Mesa Power & Light), LaSal, Utah • E-Mail: jim@footprints-inc.com

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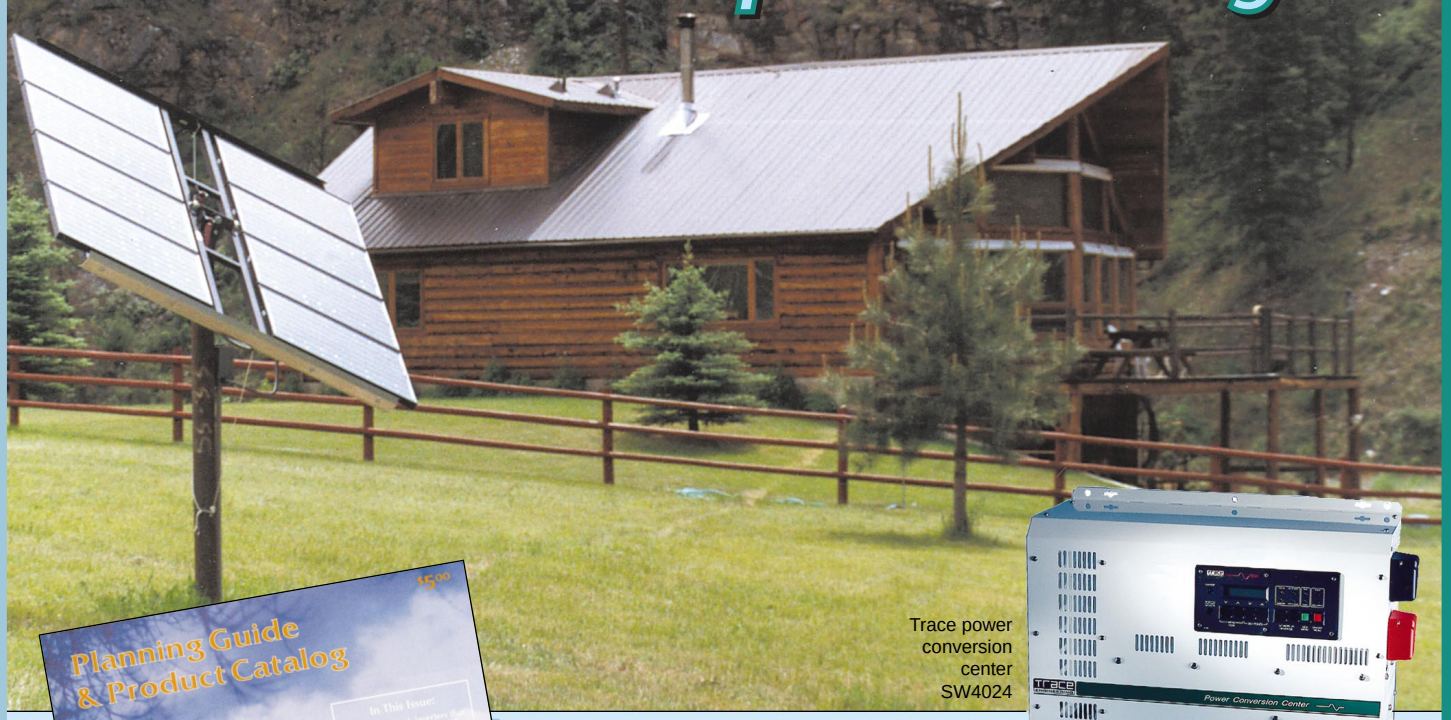

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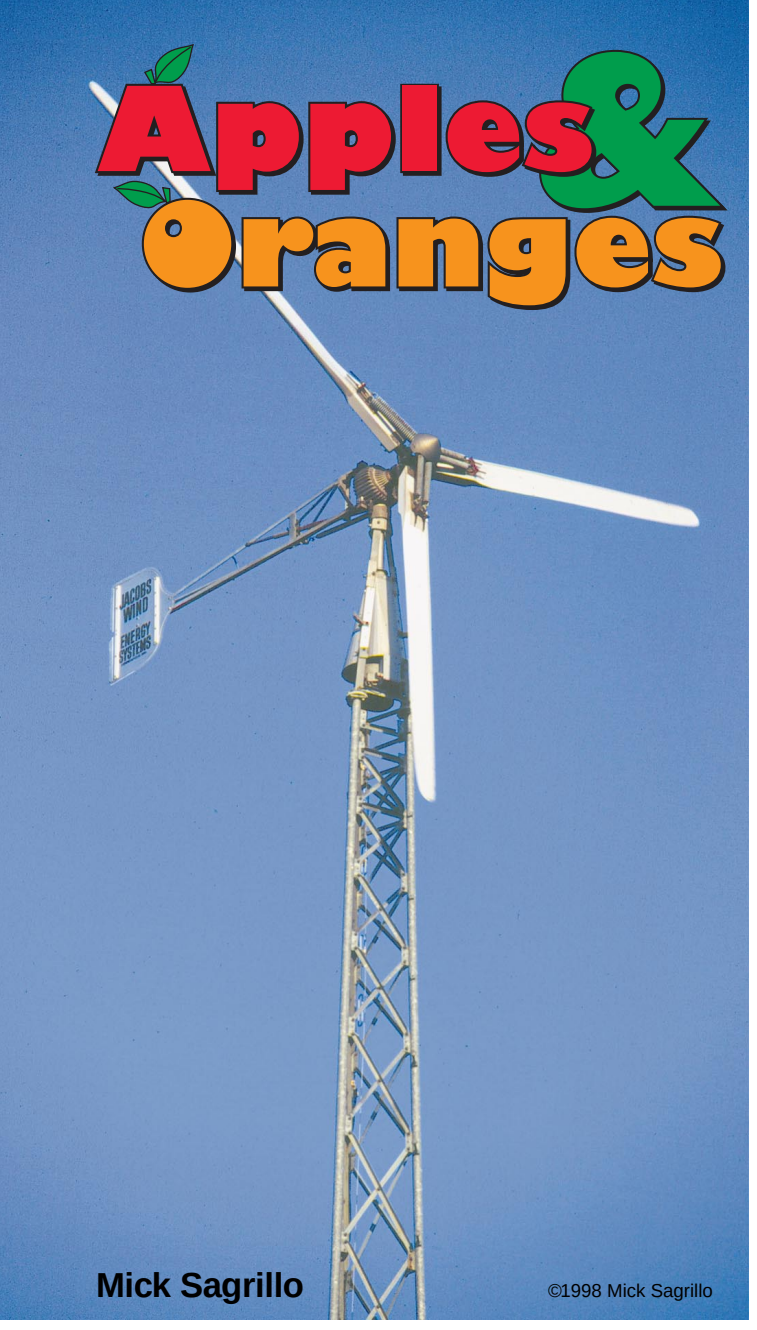


Mick Sagrillo

You're about to make the big decision: Should a wind generator be in your future? You've analyzed your resources, both environmental and monetary, and weighed the pros and cons of having a wind generator. The only question left: Which system should you choose?

I can't answer that question for you. However, I can give you the tools to help you make that big decision. Those tools are the detailed information, specifications, and power curves for a variety of wind systems.

Background

This article is an update of articles originally published in 1993 and 1995, and reflects a number of new wind generators that have come on the market. This article will review all of the commercially available wind systems that are sold in the United States by bona fide manufacturers. An explanation is in order.

In the late '70s and early '80s, the federal and state governments offered tax rebates and incentives to folks who bought renewable energy systems, including wind generators. The objective of the program was to help a fledgling RE industry get off the ground, while weaning the United States from foreign energy supplies by growing more of our own. While the intentions of the tax incentive program were good, the results for the wind industry were nearly devastating. (Similar results occurred with the other renewables, but this article will be restricted to wind electric systems.)

Scores of companies opened shop and began building wind electric equipment. Virtually all of these companies failed. Customers, however, were left with wind generators that didn't work, plus a bad taste in their mouths for RE.

The Vantage Point

Lake Michigan Wind & Sun, which I owned from 1981 through 1997, was (and still is) in the business of rebuilding and making parts for dozens of different models of wind generators that were manufactured by now defunct companies. This involved doing a lot of reverse engineering. That is, identifying system design flaws so we could correct them. By making the necessary upgrades, customers could turn a poorly designed wind generator into a usable piece of equipment.

Because of these services, I developed a unique perspective about where the wind energy marketplace was, and is now. I was in business primarily because all but a handful of wind generator manufacturers failed to build reliable equipment. As we found out about fifteen years ago, anyone can make a wind generator, but making one that will work for years is another matter entirely!

So when I say "bona fide manufacturers," I am not trying to slight anyone. I do, however, want to inform readers who the successful manufacturers are. As a former dealer for all of the U.S. manufacturers represented in this article, I have extensive experience with nearly every wind generator reviewed. While I sold all of the new wind systems available today, I do not have any allegiance to any one manufacturer. I have tried to fairly represent their products in relation to all others reviewed. They are the survivors, because they have learned how to manufacture reliable products that have withstood the test of time.

Addenda

Three more points before we start. First, this article does not include the Survivor or Soma wind generators, both of which have received press in *Home Power* at one time or another. Neither of these machines are commercially available in the United States at this time.

Second, three European manufacturers are represented by U.S. distributors, each of whom is also a factory authorized service center. Therefore, parts and repairs are available for these machines without having to wait for the next boat from the old country.

Third, a word on failures is in order. You may know someone who has, or had, one of the wind generators reviewed here that has suffered a failure of some sort, maybe even a catastrophic failure. Don't prejudge all wind generators based on a few isolated instances. Sure, there have been failures, even with the best of wind systems. Paul Gipe, author of *Wind Power For Home & Business*, reminds us to look only as far as the automotive industry for a comparison. The auto industry is a multi-billion dollar industry which has spanned over nine decades. Yet they still don't always get it right, as evidenced by the numerous annual recalls of their products.

You should be interested in the trends, not the occasional failure. Problems with a wind generator usually occur early in the life of the system. All wind generator manufacturers have experienced some failures, as have all other RE equipment manufacturers. Numerous reports of problems with a particular manufacturer should raise a red flag in your mind. However, as stated earlier, those systems have not been included in this article.

The Envelope, Please!

The following table summarizes all of the various features that you should seriously consider when shopping for your wind system. Explanations for the column headings follow. All of the specifications have been provided by the manufacturers.

Manufacturer and Model: The various models are listed in ascending (i.e., increasing) output to help with comparisons. The abbreviations for the manufacturers or their major distributor, along with their addresses and phone numbers appear at the end of the article.

All of the wind generators presented are new equipment with the exception of the remanufactured Jacobs Wind Electric generators ("short case" and "long case" models). Even though the old Jacobs has not been made for 45 years, they are still considered by many to be state-of-the-art technology. They have been remanufactured (that is, rebuilt with all new components and put back onto the streets with a warranty) by various companies for at least twenty five years. The Jacobs wind generator is the yardstick by which many judge today's wind equipment.

Rated Output refers to the maximum power output of the system before the wind generator governs. Any wind generator may peak at a higher power output than the rated output. The faster you spin a wind generator, the more it will produce, until it overproduces to the point that it burns out. Manufacturers rate their generators at a safe level well below the point of self-destruction.

Rated Wind Speed is the wind speed at which the wind generator reaches its rated output. You will notice that there is no industry standard rated wind speed, although most companies rate their systems somewhere around 25 to 28 mph. With regards to rated wind speed, note that not all wind generators are created equal, even if they have comparable rated outputs. In the past, some manufacturers have abused the concept of rated output by fudging on the rated wind speed. For example, a wind generator that reaches its rated power at 50 mph is obviously not the same animal as one which generates a comparable rated output at 25 mph. How often do you see 50 mph winds?

All of this means that the lower the rated wind speed, the more power a wind generator will produce as a function of its rated output. As a consumer, therefore, you should be particularly interested in the highest rated output at the lowest rated wind speed.

Rated Rotation Speed refers to the alternator or generator rpm at which rated output occurs. Generally, the smaller the rotor, the faster the blades spin. Rpm will have an effect on the amount of noise that the wind generator produces. We'll consider noise later.

Cut-in Wind Speed is the wind speed at which the wind generator begins producing power. For all practical purposes, there is no usable power in the wind below about 6 or 7 mph, even though the blades may be spinning. This holds true unless you greatly oversize the rotor to allow it to capture power in low wind speeds. But then you open up all sorts of worm cans when trying to control generator output at higher wind speeds.

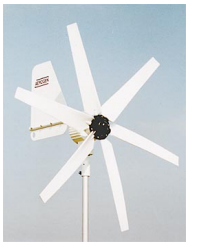
While some manufacturers claim outputs at very low wind speeds (3 to 4 mph), from my point of view a few watts does not constitute usable power. At best, this minimal output only overcomes the power losses caused by a long wire run or the voltage drop due to diodes.

Rotor Diameter: The "rotor" is defined as the entire spinning blade assembly. If the wind is the fuel, then the


	Aero2Gen	Windstream	Aero4Gen-F	FM 910	WG 913
Model					
Manufacturer	LVM	WPS	LVM	ME	ME
Rated Output	50 watts	120 watts	140 watts	90 watts	90 watts
Rated Wind Speed	46 mph	32 mph	46 mph	22 mph	22 mph
Rated Rotation Speed	1200 rpm	1900 rpm	600 rpm	600 rpm	600 rpm
Cut-in Wind Speed	5 to 6 mph	7.5 mph	5 to 6 mph	6 mph	6 mph
Rotor Diameter	1.9 feet	3.25 feet	2.8 feet	3 feet	3 feet
Number of Blades	5	2	6	6	6
Blade Material	Glass reinforced thermoplastic	Epoxy coated basswood	Glass reinforced nylon	Glass reinforced nylon	Glass reinforced nylon
Airfoil	True	True	True	True	True
Lateral Thrust	30 pounds	30 pounds	25 pounds	90 pounds	90 pounds
Governor System	Thermal switch	Tilt-up	Side-facing	Side-facing	None
Governing Wind Speed	None	33 mph	46 mph	37 mph	None
Shut-down Mechanism	None	None	None	None	None
Tower Top Weight	11 pounds	18 pounds	24 pounds	36 pounds	23 pounds
Marine Option Available?	Standard	Standard	No	No	Yes
Generator Type	PM alternator	PM DC generator	PM 3 phase alternator	PM alternator	PM alternator
Cost	$393	$497	$788	$999	$780
Dollars per Rated Watt	$19.65	$4.14	$5.63	$11.10	$8.67
Battery Systems (voltages)	12 or 24	12	12–36	12 or 24	12 or 24
Utility Intertie Available?	No	No	No	No	No
Resistance Heating?	No	No	No	No	No
Water Pumping?	No	Yes	No	Yes	Yes
Est. Mo. Energy @ 10mph (CF)	4 kWh (3%)	11kWh (13%)	10 kWh (10%)	15 kWh (14%)	15 kWh (14%)
Est. Mo. Energy @ 12mph (CF)	5kWh (4%)	17 kWh (20%)	15 kWh (15%)	22 kWh (20%)	22 kWh (20%)
Warranty	3 years	2 years	3 years	1 year	1 year
Years in production (business)	30 years	24 years	30 years	20 years	20 years
Routine Maintenance	Annual inspection	Annual inspection	Annual inspection	Visual inspection	Visual inspection
Controls	Optional	Optional voltage regulator	Optional	Purchased separately	Purchased separately
Notes	Non-governing model				Non-governing model







Aero4Gen	Aero6Gen-F	Aero8Gen-F	AIR	Aero6Gen	Mariner H500	Windseeker 502
LVM	LVM	LVM	SWWP	LVM	WPT	SWWP
280 watts	280 watts	280 watts	300 watts	420 watts	500 watts	500 watts
70 mph	46 mph	29 mph	28 mph	52 mph	28 mph	30 mph
950 rpm	600 rpm	600 rpm	2000 rpm	750 rpm	1700 rpm	2000 rpm
5 to 6 mph	5 to 6 mph	5 to 6 mph	6 mph	5 to 6 mph	7.5 mph	5 mph
2.8 feet	4 feet	5 feet	3.75 feet	4 feet	5 feet	5 feet
6	6	3	3	6	3	2
Glass reinforced nylon	Glass reinforced nylon	Laminated wood	Carbon reinforced thermoplastic	Glass reinforced nylon	Injection molded polycarbonate	Basswood
True	True	True	True	True	True	True
100 pounds	50 pounds	75 pounds	150 pounds	120 pounds	70 pounds	100 pounds
None	Side-facing	Side-facing	Aeroelastic Twist	Self-limiting windings	Tilt-up	Tilt-up
None	46 mph	29 mph	48 mph	None	28 mph	35 mph
None	None	None	Dynamic brake	None	Dynamic brake	none
19 pounds	35 pounds	40 pounds	13 pounds	28 pounds	29 pounds	20 pounds
Standard	No	No	Yes	Standard	Standard	Yes
PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator	PM alternator	PM 3 phase alternator	PM 3 phase alternator	PM alternator
$612	$1,086	$1,437	$550	$864	$1,390	$875
$2.18	$3.88	$5.13	$1.83	$2.06	$2.78	$1.75
12–36	12–48	12–48	12 or 24 or 48	12–48	12–48	12 or 24 or 48
No	No	No	No	No	No	No
No	No	No	No	No	No	No
No	No	No	No	No	No	DC
10 kWh (5 %)	20 kWh (10%)	30 kWh (15%)	35 kWh (16%)	20 kWh (7%)	36 kWh (10%)	60 kWh (17%)
15 kWh (8%)	30 kWh (15%)	41 kWh (20%)	43 kWh (20%)	30 kWh (10%)	60 kWh (17%)	90 kWh (25%)
3 years	3 years	3 years	3 years	3 years	2 years	2 years
30 years	30 years	30 years	13 years	30 years	9 (20) years	13 years
Annual inspection	Annual inspection	Annual inspection	None recommended	Annual inspection	Annual inspection	None recommended
Optional	Optional	Optional	Built-In regulator	Optional	Included	Built-in regulator
Non-governing model				Non-governing model		

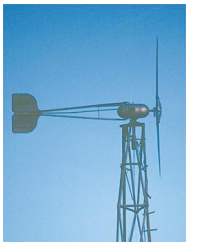




Model	Windseeker 503	Whisper 600	WT 600	Wind Baron 750	BWC 850
Manufacturer	SWWP	WPT	PE	WSW	BWC
Rated Output	500 watts	600 watts	600 watts	750 watts	850 watts
Rated Wind Speed	30 mph	25 mph	22 mph	30 mph	28 mph
Rated Rotation Speed	2000 rpm	1050 rpm	500 rpm	1100 rpm	520 rpm
Cut-in Wind Speed	5 mph	7 mph	5 to 6 mph	5 to 7 mph	8 mph
Rotor Diameter	5 feet	7 feet	8.4 feet	6.17 feet	8 feet
Number of Blades	3	2	3	3	3
Blade Material	Basswood	Injection molded polycarbonate	Fiberglass epoxy	Basswood	Pultruded fiberglass
Airfoil	True	True	True	True	Single-surface
Lateral Thrust	100 pounds	150 pounds	450 pounds	150 pounds	240 pounds
Governor System	Tilt-up	Angle	Hinged Blades	Tilt-up	Side-facing
Governing Wind Speed	35 mph	28 mph	22 mph	35 mph	35 mph
Shut-down Mechanism	none	Dynamic brake	None	Dynamic brake	None
Tower Top Weight	23 pounds	40 pounds	165 pounds	38 pounds	86 pounds
Marine Option Available?	Yes	Yes	No	Standard	Yes
Generator Type	PM alternator	PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator
Cost	$1,075	$1,190	$3,565	$1,995	$2,195-$2,375
Dollars per Rated Watt	$2.15	$1.98	$5.94	$2.66	$2.58-$2.79
Battery Systems (voltages)	12 or 24 or 48	12–240	12 or 24 or 48	12–48	12 or 24 or 48
Utility Intertie Available?	No	No	Optional	Optional	No
Resistance Heating?	No	No	Yes	Yes	No
Water Pumping?	DC	No	DC	DC	No
Est. Mo. Energy @ 10mph (CF)	60 kWh (17%)	63 kWh (16%)	62 kWh (14%)	70 kWh (13%)	80 kWh (13%)
Est. Mo. Energy @ 12mph (CF)	90 kWh (25%)	102 kWh (25%)	124 kWh (28%)	108 kWh (20%)	122 kWh (20%)
Warranty	2 years	2 years	2 years	1 year	2 years
Years in production (business)	13 years	9 (20) years	6 (16) years	7 (20) years	19 years
Routine Maintenance	None recommended	Visual inspection	Annual inspection	Visual inspection	Visual inspection
Controls	Built-in regulator	Included	Controls not included	Included	Included
Notes			Downwind		







Whisper H900	Whisper 1000	BWC 1500	Whisper H1500	Jacobs Short	WT2500	Jacobs Long
WPT	WPT	BWC	WPT	LMW&S	PE	LMW&S
900 watts	1000 watts	1500 watts	1500 watts	1500-2400 watts	2500 watts	2400-3600 watts
28 mph	25 mph	28 mph	28 mph	18 mph	26 mph	24 mph
1150 rpm	850 rpm	480 rpm	900 rpm	225 rpm	300 rpm	275 rpm
7.5 mph	7 mph	8 mph	7.5 mph	6 mph	5 to 6 mph	6 mph
7 feet	9 feet	10 feet	9 feet	14 feet	11.1 feet	14 feet
3	2	3	3	3	3	3
Injection molded polycarbonate	Fiberglass	Pultruded fiberglass	Fiberglass	Sitka spruce	Polypropylene	Sitka spruce
True	True	Single-surface	True	True	True	True
200 pounds	250 pounds	375 pounds	350 pounds	750 pounds	1124 pounds	800 pounds
Angle	Angle	Side-facing	Angle	Blade-activated	Flexible blades	Blade-activated
28 mph	27 mph	30 mph	28 mph	18 mph	27 mph	24 mph
Dynamic brake	Dynamic brake	Folding tail	Dynamic brake	Folding tail	Manual caliper brake	Folding tail
55 pounds	65 pounds	168 pounds	77 pounds	450 pounds	440 pounds	550 pounds
Yes	Standard	Yes	Yes	Yes	No	Yes
PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator	DC generator	PM 3 phase alternator	DC generator
$1,590	$1,990	$4,950-$5,395	$2,690	$6,000	$6,030	$7,000
$1.77	$1.99	$3.30-$3.60	$1.79	$2.50-$4.00	$2.41	$1.94-$2.92
12–48	12–240	12–120	24–240	24–48	24 or 48 or 120	12–200
No	Available	Available	Available	Yes	Optional	Yes
No	No	Possible	No	Yes	Yes	Yes
No	No	AC	No	DC	DC	DC
65 kWh (10%)	105 kWh (14%)	125 kWh (12%)	108 kWh (10%)	250 kWh (18%)	231 kWh (13%)	340 kWh (16%)
109 kWh (17%)	161 kWh (22%)	220 kWh (20%)	181 kWh (17%)	440 kWh (30%)	351 kWh (19%)	520 kWh (24%)
2 years	2 years	2 years	2 years	2 years	2 years	2 years
9 (20) years	9 (20) years	19 years	9 (20) years	18 years	6 (16) years	18 years
Annual inspection	Annual inspection	Visual inspection	Annual inspection	Tower top inspect & grease	Annual inspection	Tower top inspect & grease
Included	Included	Included	Included	Purchased separately	Controls not included	Purchased separately
	HV/LV option available		HV/LV option available	Remanufactured unit	Downwind	Remanufactured unit





Model	Whisper 3000	Whisper H4500	WT6000	BWC Excel	Jacobs 29-20
Manufacturer	WPT	WPT	PE	BWC	WTIC
Rated Output	3000 watts	4500 watts	6000 watts	10000 watts	20000 watts
Rated Wind Speed	25 mph	28 mph	22 mph	27 mph	25.5 mph
Rated Rotation Speed	500 rpm	550 rpm	200 rpm	350 rpm	175 rpm
Cut-in Wind Speed	7 mph	7.5 mph	5 to 6 mph	7 mph	8 mph
Rotor Diameter	14.8 feet	14.8 feet	18 feet	23 feet	29 feet
Number of Blades	2	3	3	3	3
Blade Material	Fiberglass	Fiberglass	Wood	Pultruded fiberglass	Sitka spruce
Airfoil	True	True	True	Single-surface	True
Lateral Thrust	700 pounds	1000 pounds	2248 pounds	2000 pounds	2500 pounds
Governor System	Angle	Angle	Hinged Blades	Side-facing	Blade activated & Side-facing
Governing Wind Speed	27 mph	28 mph	22 mph	33 mph	25.5 mph
Shut-down Mechanism	Dynamic brake	Dynamic brake	Manual caliper brake	Folding tail	Mechanical disc brake
Tower Top Weight	155 pounds	180 pounds	948 pounds	1020 pounds	2300 pounds
Marine Option Available?	Yes	Yes	No	Yes	Standard
Generator Type	PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator	PM 3 phase alternator	Brushless 3 ph. alternator
Cost	$4,590-$5,890	$5,790-$7,490	$13,860	$17,950-$20,475	$18,750
Dollars per Rated Watt	$1.53-$1.96	$1.29-$1.66	$2.31	$1.80-$2.05	$0.94
Battery Systems (voltages)	24–240	24–240	48 or 120 or 240	48 or 120	120
Utility Intertie Available?	Yes	Yes	Optional	Yes	Yes
Resistance Heating?	No	No	Yes	Possible	No
Water Pumping?	No	No	DC	AC	No
Est. Mo. Energy @ 10mph (CF)	316 kWh (15%)	325 kWh (10%)	618 kWh (14%)	925 kWh (13%)	1644 kWh (11%)
Est. Mo. Energy @ 12mph (CF)	507 kWh (23%)	543 kWh (17%)	931 kWh (21%)	1425 kWh (20%)	2691 kWh (18%)
Warranty	2 years	2 years	2 years	2 years	1 year
Years in production (business)	9 (20) years	9 (20) years	6 (16) years	19 years	11 years
Routine Maintenance	Annual inspection	Annual inspection	Annual inspection	Visual inspection	Annual grease & oil change
Controls	Included	Included	Controls not included	Included	Controller included
Notes	HV/LV option available	HV/LV option available	Downwind		Gear box (not direct drive)

rotor is the fuel collecting part of the wind generator. The bigger the rotor diameter, the larger the collecting area (swept area), the more power the wind generator will produce (see the Blade Diameter & Swept Area illustration on page 26). While some manufacturers rate their products at different wattages or wind speeds, the output of a wind generator is primarily a function of its swept area. Rotor diameter, therefore, is a critical feature to help you compare one wind generator against another.

Number of Blades refers to the number of blades in the rotor. This is primarily a design consideration for the manufacturer. The greater the number of blades, the more torque (rotational force) the rotor can produce. A certain amount of torque is necessary to get the rotor spinning from a stopped position. However, torque is inversely related to rotor conversion efficiency. When you are trying to generate electricity competitively with the power company, efficiency is of prime concern.

The fewer the number of blades in the rotor, the more efficient the rotor becomes. One blade is the ideal, but poses some dynamic balance problems. Two blade or three blade rotors are seen most often. The question arises, why use three blades if two blades are more efficient? Time for a digression!

"Yaw" is a term that refers to a wind generator pivoting on its bearings around the tower top to follow the continually changing direction of the wind. Two-bladed rotors pose a problem as the wind generator yaws. A two-bladed rotor actually sets up a "chatter" as it yaws, which causes a strain on all of the wind generator's mechanical components.

Chattering occurs during yawing because of the continuous changing of the position of the two blades in the plane of rotation. When a two-bladed rotor has its blades in the vertical position (that is, in line with the tower) there is little resistance to the rotor yawing around the tower. However, when the blades rotate 90 degrees so that they are in the horizontal position (that is, at right angles to the tower, or parallel to the ground) they pose maximum resistance (or inertia) to any yawing motion. The result is a rhythmic starting and stopping of the yaw twice per revolution. This starting and stopping of the yaw is what is called blade chatter.

Three-bladed rotors eliminate the chattering problem because there is never enough inertia from the one blade in the horizontal position to set up a blade chatter in the first place. The horizontal blade is more than counterbalanced by the other two blades working somewhere off on their own. In contrast to two blade rotors, well-balanced three-bladed rotors operate very smoothly with no noticeable vibration or chatter.

It should be noted that several of the manufacturers offer two blade and three blade versions of the same model. Because they're more efficient, two bladed systems put out more power at any given wind speed than the three blade versions. In my opinion, the added efficiency that a two blade version has over the three blade version is not worth the resultant shorter life span of the two blade model.

World Power Technologies has come up with a unique solution to the two-blade problem on their Whisper 1000 and 3000 wind generators. The blades are mounted on a spring plate. The spring plate flexes to absorb some of the yawing vibration and helps mitigate the yawing chatter on the 2-bladed Whisper wind generators.

Regardless of the number of blades on the wind generator, proper balancing is critical for a smooth running machine. Severe chattering or a poorly balanced rotor may result in the failure of the wind generator or, in extreme cases, the tower.

Blade Material refers to what the blade is constructed of. Within the last five years, a number of options have become available for wind generator blades.

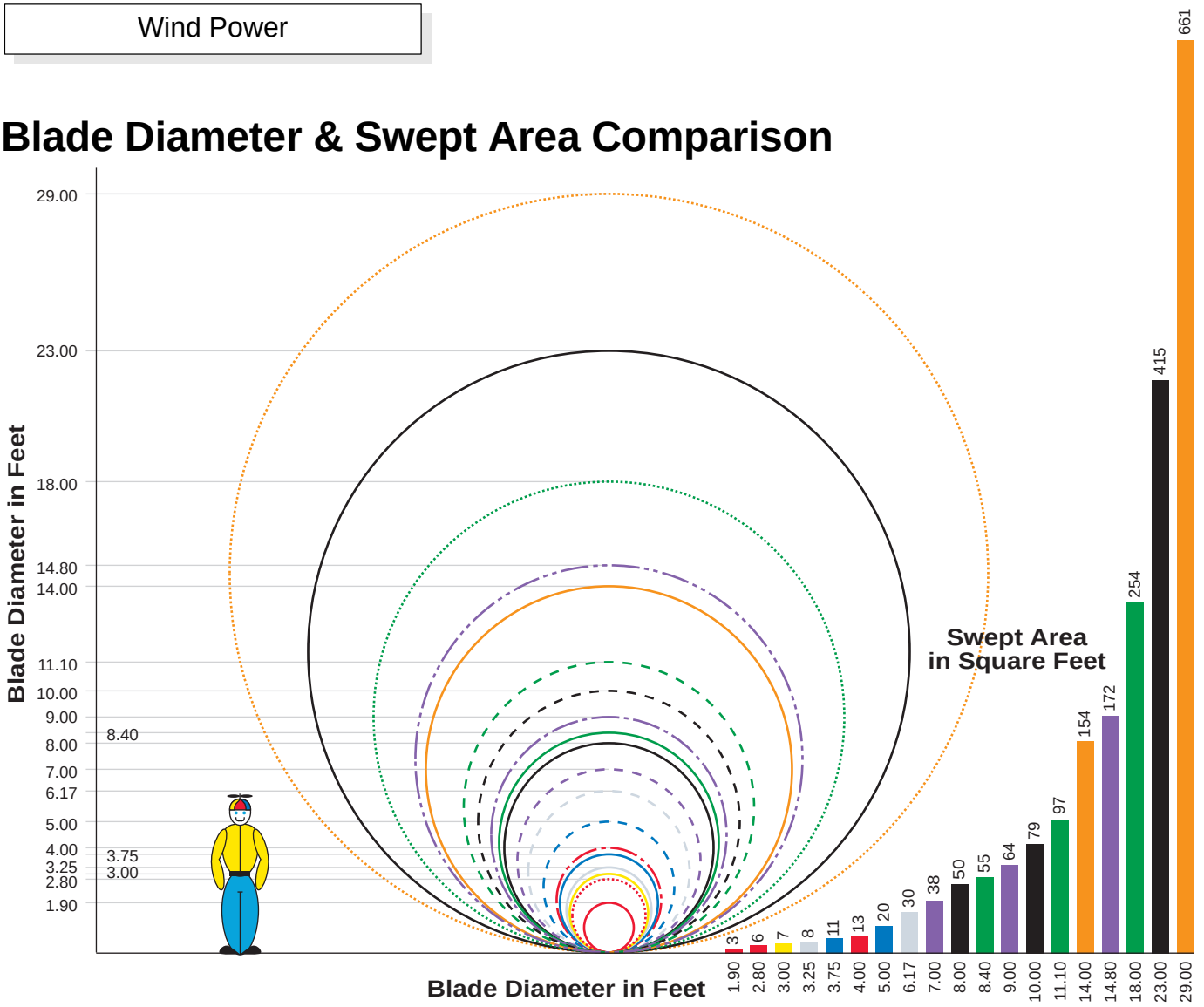
While more expensive for materials and labor, wood is still considered by many as the tried and true material of choice for blades. Blades do a lot of flexing. That's what trees did as a side job for most of their lives, as they swayed in the ever changing breezes. There is no question that sitka spruce is the primo material for wood blades. Sitka has one of the highest strength-to-weight ratios of any material ever used by blade makers, as well as airplane and boat builders.

Done properly, however, extruded fiberglass or graphite reinforced fiberglass over foam are both excellent blade materials. Several manufacturers are now using injection molded thermoplastic for their blades.

Airfoil refers to the shape of the blade. Two types of airfoils are used by wind generator manufacturers: true airfoils and what I call "single-surface" airfoils. The cross section of a true airfoil blade would look much like an airplane wing, that is, curved on one side and more or less flat on the opposite side. Single-surface airfoils have matching curves on both sides. They are easily formed by the extrusion process.

The differences between the airfoils occur in three areas: performance, noise, and manufacturing cost. True airfoils are quieter, start up in lower wind speeds, and perform better than single-surface airfoils. However, single-surface airfoils are cheaper to manufacture than the more complex true airfoils. Again, we'll deal with noise later.

Blade Diameter & Swept Area Comparison



Lateral Thrust at the Tower Top is mainly a design consideration for tower manufacturers. Lateral thrust, a critical horizontal force vector, is a function of swept area of the rotor, the resistance the tower presents to the wind, and wind speed. The greater the lateral thrust, the stronger (and therefore, more expensive) the tower must be and the larger the concrete footings must be.

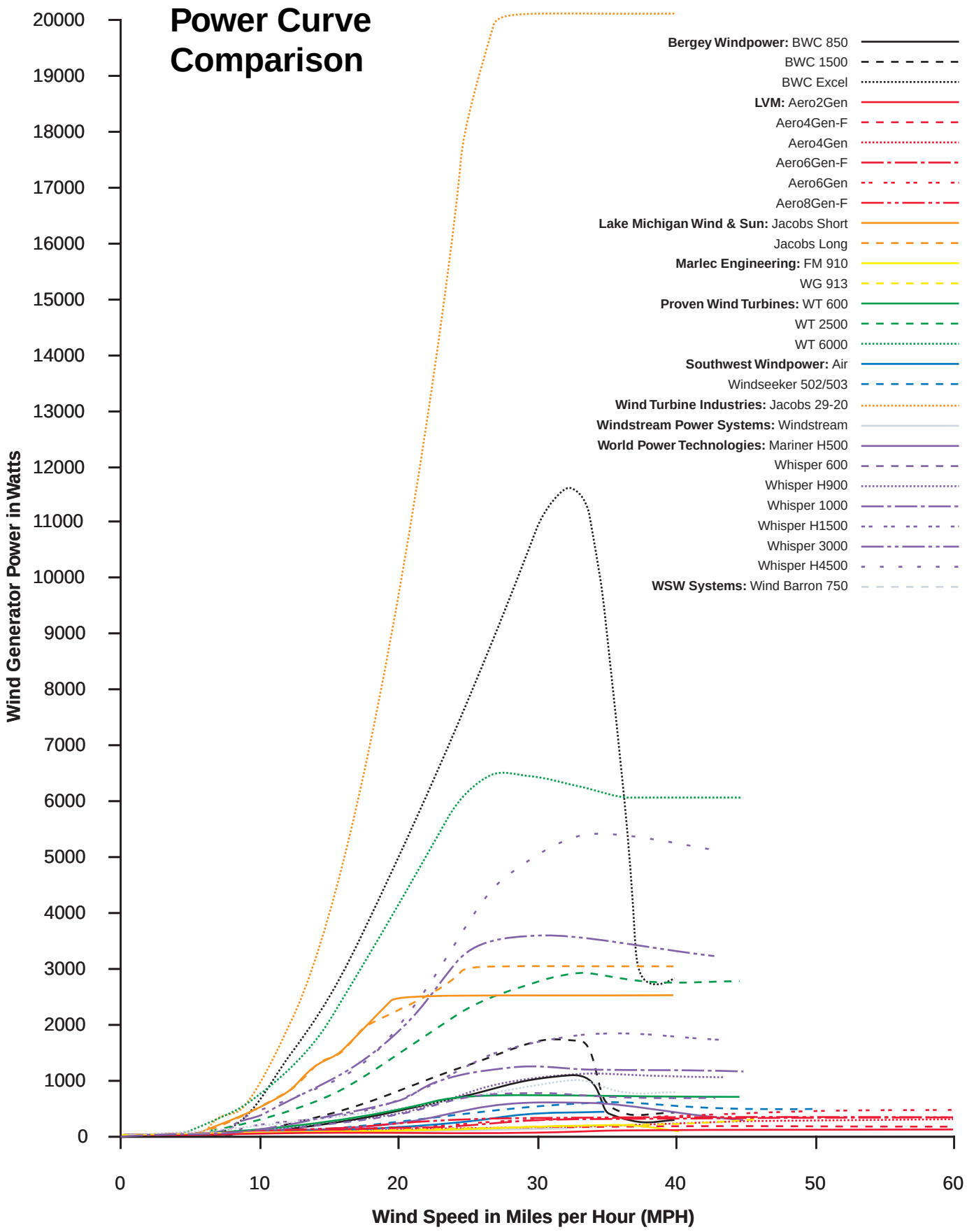
Governor System refers to the manner in which the wind generator protects itself from high winds and rotor overspeed situations. Governing is necessary for two reasons. First, the governor protects the generator itself from overproducing and burning out. Second, it protects the entire system from flying apart in high winds.

The governing devices used on all of these wind generators fall into two general categories: those that reduce the area of the rotor facing the wind, and those that change the blade pitch.

Changing the swept area of the rotor is accomplished by tilting the rotor up and out of the wind (Windstream, Wind Baron and Windseeker), by side facing the rotor out of the wind by moving it around the tower (Rutland, Aerogen, and Bergey) or by a combination of the two (Whisper). In all cases, the fixed-pitched rotor is offset either above or to the side of a pivot point. Wind pressure on the rotor causes the rotor to pivot out of the wind. These governing mechanisms are almost a foolproof method of controlling rotor speed. However, they do come with a cost. Once the rotor governs by tilting up or side facing, it produces very little power because it is no longer oriented to the wind.

Blade-activated governors (Jacobs) work by pitching the blades out of their ideal alignment to the wind. Because they operate due to centrifugal forces, the greater the rotor speed, the greater the degree of pitch. Having more moving parts than either the tilt-up or side-facing mechanisms, they are more complicated governing devices. However, they offer much better power output as you can see by comparing the power curves.

The AIR governs by what is called aeroelastic twist. At the governing wind speed, the tips of the blades twist


Power Curve Comparison
Wind Generator Power in Watts
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
Wind Speed in Miles per Hour (MPH)
Bergey Windpower: BWC 850
BWC 1500
BWC Excel
LVM: Aero2Gen
Aero4Gen-F
Aero4Gen
Aero6Gen-F
Aero6Gen
Aero8Gen-F
Lake Michigan Wind & Sun: Jacobs Short
Jacobs Long
Marlec Engineering: FM 910
WG 913
Proven Wind Turbines: WT 600
WT 2500
WT 6000
Southwest Windpower: Air
Windseeker 502/503
Wind Turbine Industries: Jacobs 29-20
Windstream Power Systems: Windstream
World Power Technologies: Mariner H500
Whisper 600
Whisper H900
Whisper 1000
Whisper H1500
Whisper 3000
Whisper H4500
WSW Systems: Wind Barron 750

and flatten so that they no longer have an ideal pitch in relation to the wind. Like the blade activated governor, this limits the rotor's speed.

Finally, the Proven turbines govern because of hinges built into the blade butts. In origami fashion, the blades fold and twist in high winds, changing the ideal blade pitch, and reducing rotor speed.

Note that some of the wind generators do not have governors. As such, they need to be more carefully watched. I would certainly not leave a wind generator without a governor unattended while I went on vacation!

Governing Wind Speed is the wind velocity at which the governing mechanism is fully operational. This occurs somewhere between the wind generators rated power output and its maximum power output.

Shut-down Mechanism refers to the manner in which the rotor can be stopped and the generator shut down. This is desirable for maintenance or repairs, or whenever else you do not want the rotor to be turning.

A common shut-down method is to fold the tail (all of these systems except the Proven turbines have tails) so that it is parallel to the blades. This takes the rotor out of the wind, and it will cease to spin. Folding the tail involves either cranking or uncranking a cable which will furl or unfurl the tail, depending on the system. The cable winch is at the base of the tower, meaning you must go out to the tower to accomplish the shutdown.

Dynamic braking is unique to permanent magnet alternators. Dynamic braking works as follows: if you short out the three phases of a permanent magnet alternator, it will overpower the ability of the rotor to spin the alternator (i.e., stall the blades) and the rotor will come to a stop. This can be done from the comfort of your home by flipping a switch on the control box.

Wind Turbine Industries and Proven utilize a mechanical brake which slows the rotor to a stop on their wind turbines. Note that some wind generators listed have no shut down mechanisms.

Tower Top Weight refers to everything that goes on top of the tower: generator, governor, rotor, tail, and turntable yaw assembly. You'll notice that there is wide variation in tower top weights. Based on experience, I side with the "school of heavy metal," those who believe that beefiness of components is directly related to the longevity of equipment life.

Marine Option Available indicates whether the unit is suitable for use in a marine environment (within one mile of an ocean or on an island), or if this option is available for an additional price. This is one area that needs close scrutiny if it applies to your location.

Generator Type describes the electrical generator that is used in the system. Three types are used: permanent magnet alternators, DC generators, and brushless alternators. A little about the pros and cons of each is in order. But first, another digression!

Electrical generators work by moving a wire (or many wires) through a magnetic field. The movement of the wire through the magnetic field induces current to flow through the wire. It's the flowing current that we want for our batteries and grid intertie inverters.

Permanent magnet (PM) alternators use, as the name implies, permanent magnets for the magnetic field. PM alternators are lighter in weight than generators that use copper wire-wound fields. Alternators produce three-phase wild ac current. "Wild ac" means that the frequency is variable with the wind speed. As rotor speed increases, so does the frequency. Wild ac cannot be used by standard 60 cycle appliances, and must be rectified to DC before it can be used in either a battery bank or a utility tie-in synchronous inverter. DC generators simply produce DC current.

Some manufacturers claim that PM alternators are better in wind systems than DC generators, primarily because there is less maintenance involved with an alternator than with a generator. DC generators have brushes, which have to be replaced periodically, maybe every six to ten years or so. PM alternators do not have brushes. From my perspective, replacing brushes once or twice a decade can hardly be construed as a maintenance problem.

The real advantage of permanent magnets to a manufacturer is that the permanent magnets are relatively cheap compared to the cost of the copper wire needed in a wound field. Cheaper materials means that a manufacturer can be more competitive in pricing the product. PM alternators also offer two advantages to a system owner. First, you can take advantage of dynamic braking, described earlier. Second, since each leg of a three phase system carries one third of the current, you can get by with a less expensive wire run.

However, PM alternators do have one disadvantage compared to generators with a wound field. (I'm going to simplify this greatly, so all you electrical engineers out there, please don't drop your teeth!) Because the magnets in a PM alternator are permanent, the amount of magnetism they exude, or their flux density, is fixed at the magnet's maximum amount. The amount of flux density in a wire-wound field magnet, however, is proportional to the amount of current that it draws. It is also somewhat proportional to the voltage present. In other words, the higher the voltage present in a wire-wound field, the more current the field will draw, and

therefore the stronger the magnet will be. As the rotor speeds up, the flux density of the field increases.

The nice thing about this arrangement is that the magnets in a wire-wound field generator put very little magnetic drag on the spinning armature when wind is blowing slow. But there's plenty of magnetic drag available when the wind is cranking and the generator is peaking. The power curve of a DC wire-wound field generator nicely follows the power available in increasing wind speeds (the cube law). That's just the way it should be. PM alternators, on the other hand, always have maximum magnetic drag on the alternator's current generating stator. This means that performance is at its peak at really only one spot on the entire power curve. All other points on the power curve are a compromise, especially at the low wind speed end of the curve, which is the part of the curve where the wind system spends most of its life.

In order to overcome this problem, manufacturers using PM alternators have to design more torque into their blades just to get the rotor spinning in low winds. But remember, from the number of blades discussion, torque is inversely related to efficiency. So while PM alternators are simpler (no brushes) and cheaper to build than DC generators, the simplicity comes at a price. To be fair, however, it should be noted that DC generators are more expensive than PM alternators.

Brushless alternators offer the best of both worlds. The fields are wire-wound rather than permanent magnet, and there are no brushes to replace. Their power curve is similar to a DC generator. On the down side, brushless alternators are considerably more complicated, and therefore, more expensive to replace or repair than either DC generators or PM alternators.

Cost refers to the cost of the complete wind generating system. In most cases, this includes any controls needed, except where noted in Controls. Different end uses might require different types of controllers (e.g., water pumping), and some end uses don't require any.

Dollars per Rated Watt refers to the system cost divided by the rated output in watts. This figure is included so that you can make direct comparisons with the cost of, for example, PV panels or a hydro plant with their associated controls.

You must decide what the wind generator's end use will be. Different end uses will utilize different control systems, which are not interchangeable.

Battery Systems is self explanatory. The voltages available for the battery systems are listed.

Utility Intertie refers to systems connected to the utility grid.

Resistance Heating means that the wind system is used for space heating. These controls are the simplest and least expensive end use option.

Water Pumping means that a control package is available to pump water with an electric pump run off the wind generator directly. No batteries! This category designates whether an ac or DC pump is used.

Because of the wide variety of controllers available, prices and options have not been included. For example, many of the smaller wind generators can be tied to the utility with the Trace SW series inverters, but are not normally advertised for that purpose. Contact the manufacturer with specific needs and for price quotes.

Estimated Monthly Energy at sites with average wind speeds of 10 mph and 12 mph is included so that you have some idea what a wind system will produce at your site. For comparisons, a very efficient home or small cabin would use 75 to 200 kilowatt-hours (kWh) per month. The "average home in the U.S." (whatever that is) uses 700 kWh/month. An all-electric home would consume from 1200 to 2500 kWh/month, as might a small business or farm. The output estimates of the various wind generators are the manufacturers' numbers, not mine. Be aware that "your mileage may vary!"

The number in parenthesis (%) is the calculated Capacity Factor (CF) for the system based on estimated monthly output. This refers to the amount of kilowatts that the wind system produces over a given period of time compared to its potential if it were running at full output all of the time. Note that different systems boast different capacity factors. The capacity factor for a wind generator is primarily a function of the swept area of the rotor, the rated wind speed of the system, and to a lesser extent, the type of airfoil used (true or single-surfaced). In general, the lower the rated wind speed and the larger the swept area, the greater the capacity factor.

Warranty: All the manufacturers warrant their products for parts and labor (in-house repairs at their facility) against defects in materials or workmanship. This means that you must return the defective part to the factory for evaluation and repair or replacement at the discretion of the factory. Standard practice is that you will pay shipping both ways, just as with any other consumer good. Warranties do not cover improper installation, neglect, use of unauthorized components, abuse or "acts of God" (this is why you have homeowners' insurance). Manufacturer liability is for the defective part only, and does not include incidental or consequential damages.

Years in Production (Business) tells you how long the company has been around. Where there is a parenthesis, the first number refers to how long the current wind generator model has been in production, while the second refers to how long the company has been in business, either making another turbine or doing research and development.

Routine Maintenance refers to what needs to be done to the wind generator to keep it in prime operating condition for a long life. How long? That's hard to say. Several years ago, I took down an old Jacobs that had seen 60 years of nearly continuous duty. While the old Jacobs was certainly an over-designed and over-built wind generator from an era that valued quality workmanship; properly cared for, any one of the new systems should match half that span, given proper attention.

This doesn't mean that you will never have to replace parts or do major repairs. Blades will need repainting and some new tape on the leading edge eventually. Bearings wear out and need replacing. Some systems, as noted, need annual greasing or oil changes. Bolts might loosen and need tightening. Adjustments might be needed here or there. It is unrealistic to expect something as complex as a wind generator operating continuously in a harsh environment to work flawlessly with no maintenance. If that's your expectation, then don't buy a wind generator.

Some manufacturers recommend only a visual inspection as their maintenance. Bergey Windpower Company, for example, suggests that after you install one of their units, once a year you need to go out to the base of the tower and look up to see if it is still running. That's it for another year! While there is no question that Bergey builds one of the most maintenance-free wind generators available in the industry, I am a little more conservative than they are. It is well born out that the life of a wind generator is directly related to the owner's involvement with the system and its maintenance. If you don't at least periodically inspect your wind generator, you may be picking it up off the ground someday!

Most of the catastrophic failures that I have seen over the years were due to something as seemingly inconsequential as a bolt loosening and not being attended to. I believe that the prudent wind generator owner should thoroughly inspect the system twice a year at a minimum; once on a nice fall day before winter hits and again on a warm spring day before thunderstorm season. As they say, prevention is the best cure! Preventative maintenance becomes more important as your investment in the system increases.

Most of the great strides in reduced maintenance have come not from new designs, but from new materials. The designs for today's wind generators have been around for a long time. For example, the side-facing governing mechanism used by Bergey and Wind Turbine Industries was patented in 1898 and originally used on waterpumpers. The tilt-up style of governing used on the Wind Baron and the Windseeker was patented in 1931. And the blade-activated governor used on the old as well as the new Jacobs was patented in 1949. However, such things as graphite-impregnated nylon used in some bushings or the aliphatic resin tapes that are used for leading edge protection were just being developed fifteen years ago. Continuous upgrading by incorporating modern materials in wind system components has helped greatly in the maintenance arena. The manufacturer who cuts corners by using cheap materials is courting trouble with customers.

One new development: World Power Technology's new angle governor on their Whisper wind generators is a new design that was granted a patent just this year.

Controls tells you what is included in the system price or what you may need to budget for if it's not included.

Notes is a miscellaneous catch all. One explanation is necessary. Some of the Whisper wind systems are available with a high voltage/low voltage (HV/LV) option. This means the wind generator is wound for 240 vac, and a step down transformer is included near the controls to step the voltage down to the 12 to 48 VDC battery voltage. Since high voltage results in low current to transfer a given amount of power through the wire run, the HV/LV option means that you can site your wind system up to a mile away from the battery bank, something unheard of with low voltage DC generation.

Power Curves

The power curves for all of the wind systems reviewed have been put together so that you can more easily compare one system to another. The curves compare the power output of the various systems as a function of wind speed. However, be aware that this is still an "apples and oranges" comparison because there is no standard rated wind speed. However, some reasonable comparisons can be made.

Noise

Questions often arise about how much noise a particular wind generator makes. For the most part, a well-designed wind generator is relatively quiet. By the time the wind generator is cranking enough to cause some noise, trees are rustling and buildings are rattling as well.

Noise from a wind generator can come from a number of sources, including mechanical noise, blade noise, or blade orientation. Mechanical noise would emanate from something such as a gearbox. Most of the systems reviewed are direct drive, meaning that the blade is coupled directly to the generating device. Only the 20 kW Jacobs utilizes a gearbox.

Blade noises can be caused by rpm and/or the airfoil. Rpm should be obvious. The faster something spins, the more noise it is likely to make. Being the slowest speed machines on the market, the old and new Jakes are the quietest wind machines available. The shape of the airfoil can also have an effect of the amount of noise the blades make. As a rule, true airfoils are quieter than single-surface airfoils.

The Proven wind turbines are downwind wind generators, with the blades passing through a wind wake downwind of the tower. Some wind generator blades develop a cyclic tower shadow noise running in this configuration. I have no experience with the Proven wind turbines, so I cannot attest to the presence or absence of this tower shadow noise.

Finally, rotors that side face or tilt up create some noise as the rotor changes its plane of rotation when governing.

Installation

The installation of a wind generator on a tower can be accomplished with either the use of a gin pole or a crane. A gin pole is a type of boom that is mounted on top of your tower. Using cables and rigging, either the entire wind generator or its component parts are hoisted to the top of the tower where they are installed. This is relatively easy to do with the smaller systems. However, only an experienced crew should attempt this with something as large as a 10 kW or larger system. These wind generators are probably better installed with the help of a crane.

An alternative is to install a tilt-up tower. Tilt-up towers tilt down to ground level, where the wind generator can be easily installed and serviced. Tilt-up towers are generally more expensive than guyed towers but less expensive than freestanding towers.

UL/CSA/CE Ratings

While some of the wind generators have or are acquiring a CE rating in Europe, at this time none of the systems are UL listed in the United States, or have CSA approval in Canada. As yet, these ratings have not been required.

Delivery time

A word needs to be said about the lead time required to get your wind system once you have placed an order. A wind generator is a very complex device made up of a wide variety of components and materials. All of the manufacturers represented here are small companies working with many subcontractors and suppliers. As such, they are some times at the mercy of events beyond their control.

Home-sized wind generators are not manufactured on an assembly line like many other consumer products. Instead, the “gennys” are made in batches ranging from a handful to a few dozen at a time. When you place an order, your machine becomes part of a batch. The manufacturer may already have a batch going that your order can plug into. If not, your turn comes when the next batch is started. As a customer, you need to be a little understanding about the lead time for the machine you order. In all likelihood, your wind generator will not be “instantly” available unless you happen to find a dealer who has the particular machine you want in stock, a rare occasion. Lead times can vary from three weeks to as long as sixteen weeks.

A few customers have had rather bad experiences with unusually long lead times. Some have felt that they have been “jerked around” by the manufacturer. While I can’t say that this has never happened, I will defend the manufacturers as being pretty good guys on the whole. They really are concerned about satisfying their customers. After all, without you, the customer, they’re out of business.

My Choice?

“So, Mick, what do you recommend?” is the most frequently asked question that I get. The answer: it all depends on your situation.

I can honestly say that properly specified and installed, any one of these machines will do a fine job of producing electricity for you for many years. They all have their own personalities and idiosyncrasies, just like the cars we drive. And, just like the cars we drive, they come in a variety of shapes and prices. Finally, just like the cars we choose, they all will get us from point A to point B. However, not all cars, nor all wind generators, are created equal. As the saying goes, “You get what you pay for.” Quality always comes at a price.

You now have all of the tools you need before you to make an educated choice. Seek out other wind power users and gain from their experiences. By all means, discuss owner satisfaction with your wind generator dealer. Make sure that you digest the facts and figures and assess your needs and pocketbook, so that you may choose well.

The Manufacturers

The manufacturers for the systems reviewed can be contacted for prices or more information, or you can

contact your favorite wind generator dealer. The abbreviations preceding the manufacturers name are those listed in the table.

BWC: Bergey Windpower Company, 2001 Priestly Ave., Norman, OK 73069 • 405-364-4212 • Fax: 405-364-2078. Manufactures the BWC 850, the 1500, and the Excel.

LMW&S: Lake Michigan Wind & Sun, 1015 County U, Sturgeon Bay, WI 54235-8353 • 920-743-0456 • Fax: 920-740-0466. Remanufactures the old Jacobs "short case" and Jacobs "long case," and is the North American distributor for the Aerogen Wind Generators.

LVM: The Aerogen line of wind generators is manufactured by LVM Ltd, in England, and distributed by Lake Michigan Wind & Sun (see above).

ME: Trillium Windmills, Inc., 1843 Marchmont Rd., R.R. #2, Orillia, Ontario, L3V 6H2, Canada • 705-326-6513 • Fax: 705-326-2778. North American distributor for the Rutland Windchargers (manufactured by Marlec Engineering Co., Ltd. of England).

PE: The Proven Wind Turbines are manufactured by Proven Wind Turbines in Scotland, and distributed in the US by WSW Systems (see below).

SWWP: Southwest Windpower, Inc., PO Box 2190, Flagstaff, AZ 86003 • 602-779-9463 • Fax: 602-779-1485. Manufactures the Windseeker 502 and 503, and the AIR.

WPS: Windstream Power Systems, One Mill Street, PO Box 1604, Burlington, VT 05402-1604 • 802-658-0075 • Fax: 802-658-1098. Manufactures the Windstream.

WPT: World Power Technologies, 19 Lake Avenue North, Duluth, MN 55802 • 218-722-1492 • Fax: 218-722-0791. Manufactures the Whisper wind generators.

WSW: WSW Systems, 2101 North Forth St., Flagstaff, AZ 86004 • 520-774-6341 • Fax: 520-774-6451. Manufactures the Wind Baron 750 and distributes the Proven Wind Turbines.

WTIC: Wind Turbine Industries, Corp., 16801 Industrial Circle SE, Prior Lake, MN 55372 • 612-447-6064 • Fax: 612-447-6050. Manufactures the Jacobs 29-20.

Access

Mick Sagrillo tests wind generators for Lake Michigan Wind & Sun, and can be reached at E3971 Bluebird Rd., Forestville, WI 54213 • 920-837-7523.

SOLAR UTILITY INC

full page

four color
on negatives

This is page 33

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These products are designed specifically for systems requiring large arrays. AstroPower's panels provide the largest increment of pre-tested, pre-wired power available on the market–up to 480 watts per panel–and they can still be handled and installed by two people. Uncrate them, mount them, plug them in, and you're up and running… much quicker and easier than field assembly.

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240 vac Direct Drive Hydro

John Hermans

Above: John and Robyn with kids Ben and Jill over the tail race and main shaft.

For seven years, my family and I have been deriving 100% of our electrical energy needs from a 240 vac alternator driven by a low head, axial flow turbine. During this time and the years leading to its development and installation, I read many articles on micro hydro electrical systems.

It is apparent that in recent years the number of micro-hydro installations have increased. This is due to their higher efficiency of operation and the availability of smaller, less costly units. These are primarily designed for constant battery charging. I am always intrigued to read of an installation that has a pure 240 vac output, but it is quite rare to find such an article, thus I am prompted to write this one.

Site Selection

Of the hundreds of existing micro-hydro installations along the east coast of Australia, very few would readily adapt to a 240 vac output due to the small volume of water on which they operate. But, there are a large number of potential sites that are suitable for 240 vac which have low to medium head (1 to 6 meters) and flow rates which are considerably higher. This situation usually requires a river frontage property as opposed to a creek. It is the Nicholson River of East Gippsland, Victoria, Australia which provides us with just that: a low head (1.2 meters) but high volume (100 to 2000 liters per second).

The Weir

Perhaps the only real obstacle to the construction of a similar system is the ability to build a water impermeable concrete and rock wall. This wall is required to allow water to enter the penstock (the piping to the turbine). It should not only resist flood damage, but should not initiate erosion problems in times of flood. Its potential to be undermined by water under pressure must be avoided. Such a site should preferably have a monolithic rock base for the majority of its length. The use of low level walls across rivers gives rise to minimal ecological impact. It is evident from my own installation with a small fish ladder that aquatic life is still free to move up and down the stream. This is most certainly not the case only 1 kilometer upstream, where there is a 10 meter high concrete weir built to supply water to the nearby coastal towns.

Above: An upstream view of the hydro installation and the 1.2 meter high weir. The “power tower” in the foreground houses the alternator and pump.

Low head installations are often subject to annual submergence by local flooding. In my case, this has minimal impact on the mechanical components. My only preparation for such a submergence is to remove and carry the alternator to high ground. This is a small price to pay for the high returns we receive from this system.

Providing an installation with high flood resistance can be achieved if some basic principles are used. To increase flood resistance:

- Use high strength concrete with water-proofing admixes at rock interfaces and include multiple drilled-in-place 12 mm rebar anchors.
- Use large diameter stainless steel anchor bolts with epoxy resins.
- Use heavy steel construction.
- Use pipe bracing.
- Use metal plate water and debris reflectors.
- Galvanize and epoxy paint steel that is frequently submerged.
- Position mechanical components out of line of flowing debris.

It is very possible for an entire system to be swept away. This threat has undoubtedly prevented many people from going ahead with their installations. On one occasion, I had four meters of flood water over the top of the alternator “power tower” for two days. Yet, my only chore after the waters subsided was to pump fresh grease into the bearings in order to displace water. After 20,000 hours, the running gear has been submerged at least six times and the bearings have been changed only once.

Below: Turbine (not running) outlet showing PTO shaft with CV joints from an old Subaru.

Pumping Water

An additional benefit of my turbine is its use in driving a Grundfos multi-stage centrifugal pump. This pump delivers 1 liter per second to a 220 thousand liter concrete tank situated 100 meters vertically above the river. This is achieved by taking the v-belts off the alternator and flywheel and placing them on the pump.

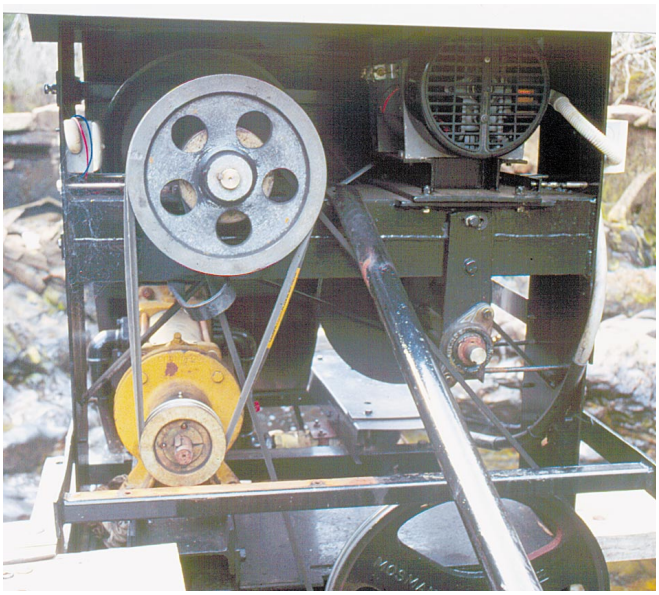
Flywheel Use

The constant output of the 4 kVa alternator is relatively small (1.2 kVa) but is adequate for all our household and workshop requirements. (The exception is my welder, which is diesel powered. Putting out 250 Amps at 40 Volts does not come easily in many alternative energy systems). The use of a 30 kilogram, 400 mm diameter steel flywheel, spinning at 50 revolutions per second, is invaluable for starting induction motors up to 1.5 hp. Its stored energy is transferred smoothly to the alternator when sudden heavy loads are applied. This leads to minimal voltage and frequency drop, eliminating lighting flicker.

Design for Low Flow

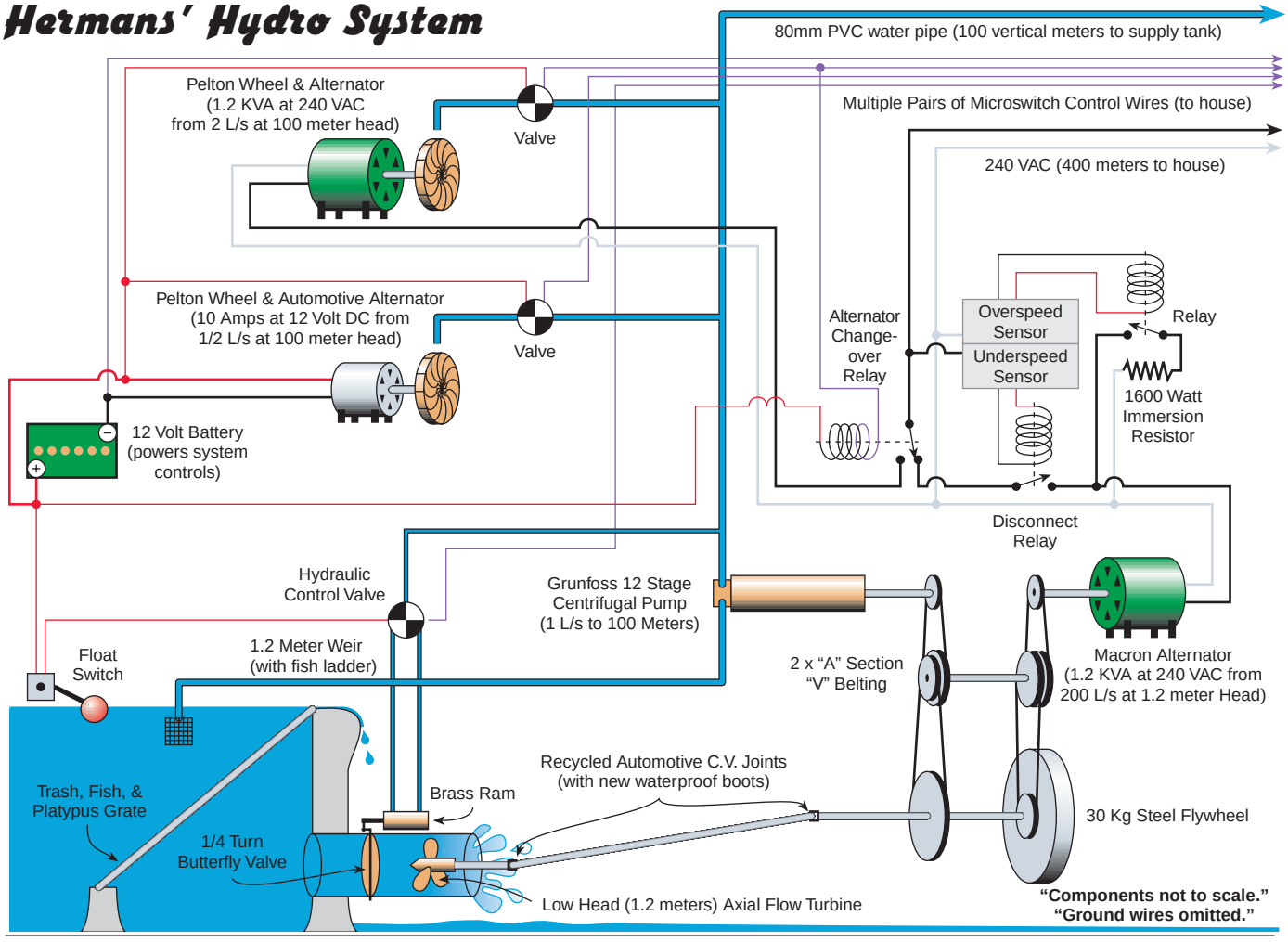
The axial flow water turbine does not lend itself to throttling via reduction of the water flow through the turbine pipe. 200 liters per second is required to run the turbine. In summer, and other times of flows less than 200 liters per second, a turbine shutoff valve is

Above: The Power Tower houses the alternator (upper left), the 30 kg flywheel (lower left), and the pump (lower right).

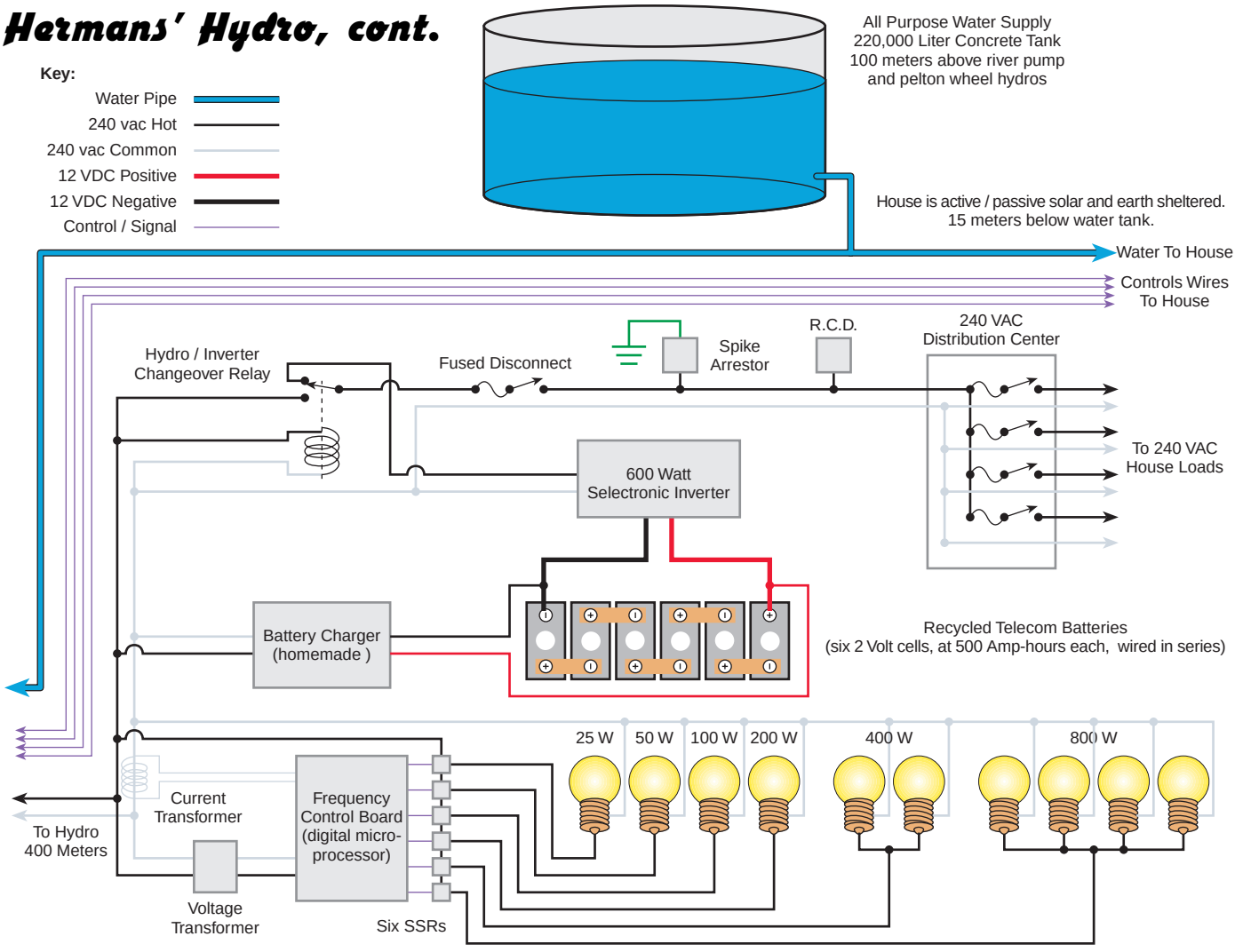


Above: The other side of the Power Tower showing the drive shaft, primary step-up belting, and the pump (in pumping mode).

Hermans' Hydro System



Hermans' Hydro, cont.



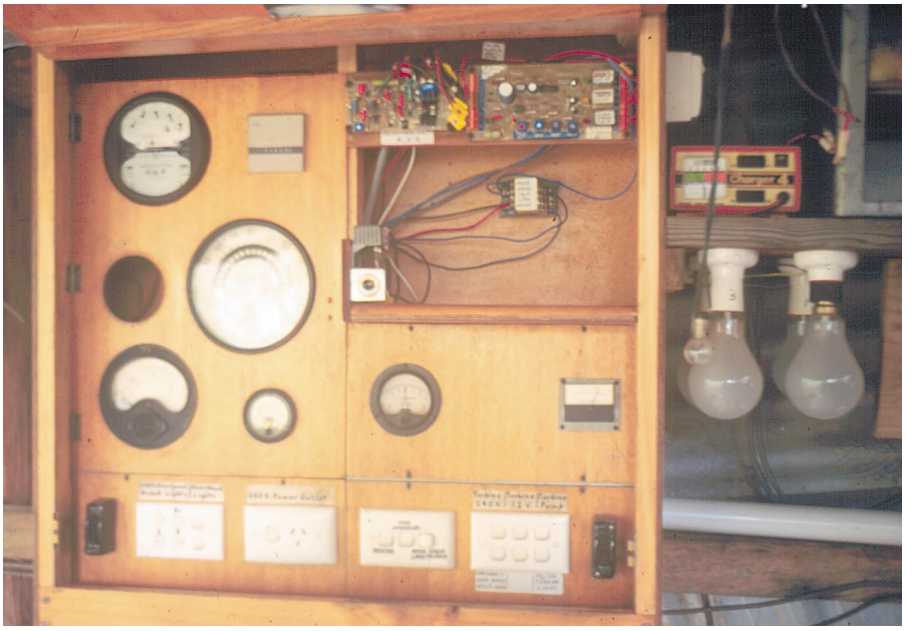
essential. A falling weir water level is a common problem in many installations and is overcome in my system in two ways. First, I use a bilge pump float switch in the weir water supply. This opens the control switch for the turbine valve when the water level falls approximately 70 mm. The control switch closes the turbine valve in the penstock, shutting the system down. When the water level is restored the switch closes to start the alternator spinning again. If the turbine takes 200 l/s to run constantly, but only 160 l/s was available, then the alternator-turbine would have a duty cycle of 80%, running 20 minutes on and 5 minutes off.

A preferred method of dealing with variable flow rates is to use a cross-flow turbine which can be throttled by either a pivoting guidevane or a shutter arrangement across the water jet. This throttling ability, and the ease of home manufacture, makes this turbine a first choice for many low head installations.

To counter low flows, we also use a small battery bank and inverter. Our TV, stereo, and computer are all

Left: A home-made mercury bulb float switch controls the butterfly valve that adjusts flow through the turbine.

Right: A hydraulic ram, driven by water pressure from the tank 100 meters higher, actuates the butterfly valve.



Above: Control and meter box with lightbulbs used for diversion loads.

permanently wired to a 600 watt inverter. All other loads are automatically switched over to the inverter when the alternator switches off by either the float switch or manual controls. A slight flicker of the lights at night is all that is evident. In times of low river flow, most of my 1.2 kVa goes into battery charging.

Frequency Control

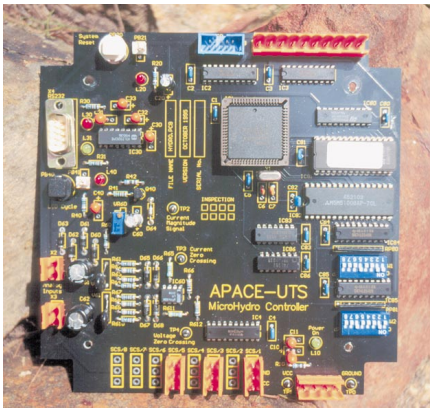
The heart of this micro-hydro installation is the electronic "stand alone computer" frequency control board. For four years, I had a very crude electronic load control which shunted unused power into either 400 or 800 watt dummy loads. This system was less than adequate on many occasions. My quest to find a more appropriate controller was not an easy one. After much searching, I chanced upon an electronic control board which not only works well, but leads the technology world-wide. I now have the first installation in Australia.

An Australian electronics engineer designed the frequency control board in conjunction with Appropriate Technology for Communities and the Environment (APACE) located at the University of Technology Sydney (UTS). Its development began when APACE, an Australian government aid program, began installing 240 vac micro-hydro systems in the Pacific Islands. UTS has been using this control board as an educational tool for senior and post graduate students for over ten years. It has undergone thousands of hours of testing.

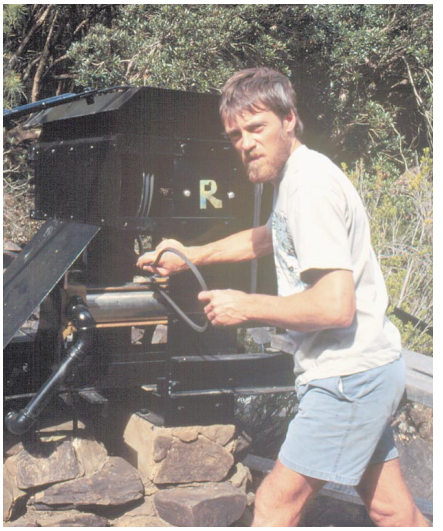
The circuit board itself is only 150 mm square. It uses a digital microprocessor incorporating a special algorithm to maintain alternator frequency to within one cycle per second on either side of 50 Hz. The software resides in ROM and the unit is programmed to handle the high speed response required for low kW output micro-hydro systems. For over three years, this unit has proved faultless in my system.

The control method maintains full load on the alternator by matching the power output to the load. This is accomplished by monitoring the frequency for variation and switching dummy loads.

In my case, the dummy loads are six incandescent light bulb sets: 25, 50, 100, 200, 400, and 800 watts. The digital microprocessor determines which combination of the six loads to have on in order to maintain 50 Hz, and hence 240 volts. There are 64 combinations available, from 25 to 1600 watts in 25 watt increments. Thus, if the house is using little of the generated power, say only 250 watts of night lighting, the controller will make



Left: The frequency control board, made by the University of Technology, Sydney, keeps the ac waveform within spec.



Right: John changes belts to switch the hydro from alternator to pump.

qty	item	cost	%
1	Concrete water tank	$4,000	28%
1	240 V pelton wheel/alternator	$3,000	21%
450	meters of 80mm PVC Pipe	$1,500	10%
2	Macron 4 KVA alternators	$1,300	9%
400	meters of paired cable	$1,200	8%
1	Grundfoss centrifugal pump	$1,000	7%
1	Frequency controller	$1,000	7%
1	Tower of Power	$600	4%
1	Concrete weir	$500	3%
1	12 V pelton wheel/alternator	$200	1%
	total	$14,300	

up the difference. It will turn on the 50, 100, and 800 watt dummy loads to produce the total 1200 watt load requirement. The load adjustments occur at the rate of ten per second, in 25 watt steps, which at times gives the appearance of a disco going on at the rear of my garage. The light bulbs still manage a few years of use.

Damage Control

Included with my control system is a separate circuit board which is mounted close to the alternator. In case of control board or power line failure, it senses potentially damaging under and over frequency. It then responds by shutting down the turbine-alternator unit.

Access

Author: John Hermans, 320 Bellbird Rd., Clifton Creek, Vic. 3875, Australia

Micro-hydro governor available from J. A. Brebner PL, 74 Second St., Ashbury, N. S. W. 2193, Australia
E-Mail: pfa@ozemail.com.au
Web: www.pactok.net.au/docs/apace/home.htm

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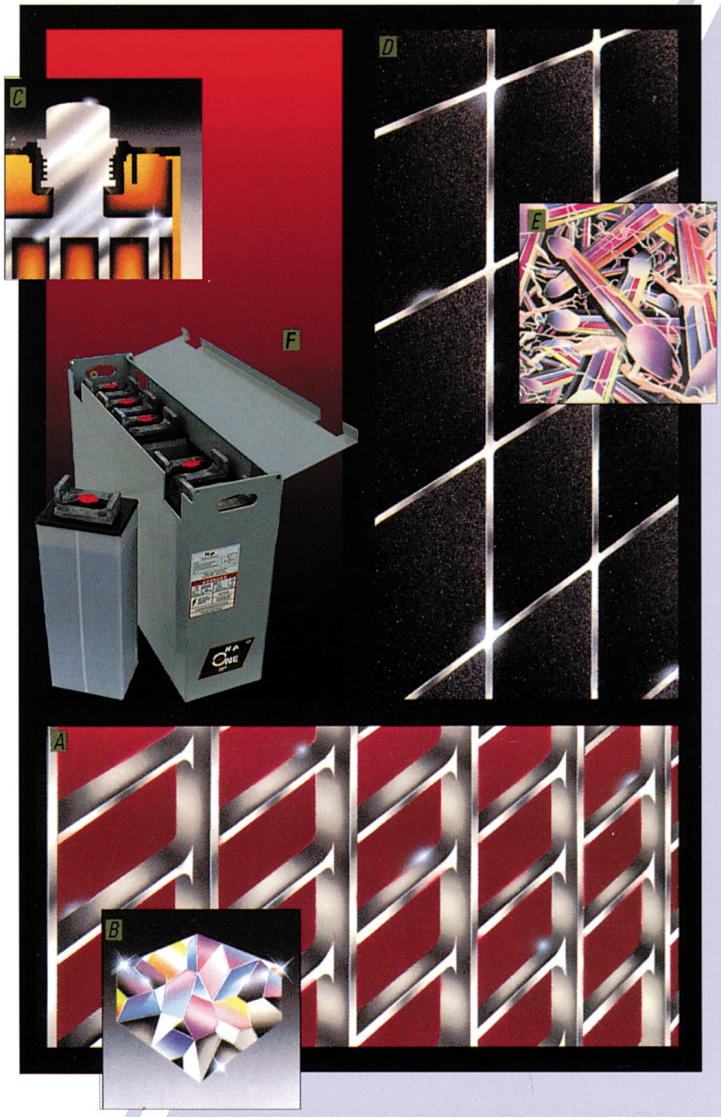

E *This process known as fibrillation, locks the active material into place and virtually eliminates flaking and shedding - the chief causes of battery failure.*

F *Tested at the National Battery Testing facility batteries with **H.U.P.** have been shown to increase working life by at least 20%, with absolutely no sacrifice of capacity! In fact, **H.U.P.** batteries deliver full capacity longer, have faster voltage recovery with lower internal resistance, and last longer than conventional batteries. For more power in your Renewable Energy System look for the **H.U.P. Solar-One**™ label. High **U**tilization **P**ositive plate technology only from:*

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The Great American Veggie Van Adventure

Josh and Kaia Tickell

Powered by vegetable oil, the Veggie Van took us 10,000 miles across the United States. The van visited 20 major cities and 25 states where people smelled the clean, french fry-like exhaust. Over 40 million people saw the multicolored Veggie Van drive across their television screens. Thousands attended presentations about the van, and hundreds of thousands more read about the van in their local newspapers. More than half a million people visited the Veggie Van website.

What began as a college project culminated during the summer of 1997 in a massive public awareness campaign. We knew that we had reached people from almost every walk of life when a person begging on the street shouted to us, “Hey, isn’t that the van that runs on that used restaurant oil?” We nodded in response and as we drove away the man shouted, “That’s incredible, good luck!”

Fields of Fuel in Germany

Luck had once taken us to a traditional farm in picturesque southern Germany where we had seen vehicles fueled by vegetable oil. While studying organic agriculture and living on this farm, we noticed that the farmers were continuously hauling tanks full of yellow liquid. The farmers told us, “This is fuel from the canola plants which grow on our farm and on Jorg’s farm up the road. We put it in the diesels and they smell good.” To our amazement, the farmers poured the yellow liquid into their car and tractor, which then emitted a pleasant smelling exhaust.

What You Didn’t Know About the Diesel Engine

More than 100 years ago, a brilliant inventor named Rudolph Diesel designed the original diesel engine to run on vegetable oil. Over time, the diesel engine was modified to run on a cheap, dirty by-product of gasoline production, labeled “diesel fuel.” Straight vegetable oil is too thick to run in most modern diesel engines, but biodiesel, a biodegradable, non-toxic fuel made from vegetable oil, works in any unmodified diesel engine. Not only does biodiesel require zero modifications to the engine, but this fuel works either by itself or blended with petroleum diesel! The process of converting vegetable oil into biodiesel fuel is called transesterification and is far less complex than it sounds. In fact, the process is so simple that it can be done in a blender!

Above: The Veggie Van with the Green Grease Machine in tow.

A Simple Reaction

The chemicals needed to make biodiesel are cheap and easy to find. Any vegetable oil (such as used restaurant cooking oil), methanol (a clear alcohol used as racing fuel), and lye (a white powdery substance used as drain cleaner) are the basic components. During the conversion process, the ingredients are heated and mixed, and biodiesel and glycerin are created. The glycerin can be used to make soap or any one of thousands of other products. Biodiesel fuel can be used directly in an unmodified diesel engine and it can burn up to 75% cleaner than petroleum diesel fuel. Since biodiesel can be made from used cooking oil, we decided that it was time for us to take this idea on the road.

How it All Began

Enamored with the idea of transforming the fast food restaurant fryers of America into a network of low-cost gas stations, we decided to build a portable fuel processor, buy a motor home with a diesel engine, and travel across the country. Sitting on a local used car lot was a 1986 Winnebago LeSharo with a 2.1 liter Renault diesel engine that would soon become the "Veggie Van." The small, white van had the perfect engine and it got 25 miles to the gallon. Two purple, gleaming photovoltaic panels soon adorned its roof line. The panels allowed us to stay "off the grid" because they powered the van's refrigerator, lights, computer, power tools, and video equipment. Fueled by soft drinks and pizza, a rag-tag group of volunteer art students painted sunflowers and earth symbols on the van. The Van Gogh-esque graphics and some well placed lettering told any onlooker that this Veggie Van was "Powered by Vegetable Oil," got "1,300 Miles Per Acre" and was on the "Veggie Van USA Tour." The exterior of the van hinted of the mechanical magic occurring inside the engine, which remained totally unmodified.

The Green Grease Machine

The "Green Grease Machine" was created when we mixed salvaged parts from scrap yards, boat marinas, and hardware store plumbing supplies with our blood, sweat, and used cooking oil. This trailer-mounted work of art makes clean burning biodiesel out of used restaurant vegetable oil. First, an old Champion juicer motor sucks vegetable oil from a restaurant fryer, then a converted tug boat fuel filter strains the french fries and other bits of food out of the oil, and lastly the oil moves into a converted 1976 military steam kettle where an outboard boat motor swirls the ingredients together!

Below: The Green Grease Machine performs transesterification.

The First Time We Turned it On

Some very interesting experiments with vegetable oil and fryer grease gave way to our first large batch of biodiesel fuel. Covered in grease, we watched as the dark fuel was poured into a secondary tank of our test vehicle, a diesel VW. As soon as the tank's valve was opened, the fuel began to gurgle, the engine changed pitch, and the air was filled with the odor of super-fried vegetable oil. Our experimental fuel

Left: A fuel filter, salvaged from a tug boat, gets the bits of french fries out of the cooking oil.

actually worked! For months, we experimented with various blends of vegetable oil as fuel, succeeding to run our VW Jetta on up to 80% straight fryer grease for over 5,000 miles.

Life On the Road

Phone calls and e-mails poured in from around the country as we planned the 1997 Veggie Van USA Tour. We talked to reporters, environmental organizations, music festival managers, and school teachers as we scheduled tour events and planned our route. The trip itinerary filled quickly. We had the Veggie Van, the Green Grease Machine, and an almost endless supply of grease. Thus began the 1997 Veggie Van USA Tour.

We ran the Veggie Van on 100% biodiesel fuel for 10,000 miles from coast to coast. The Veggie Van towed the Green Grease Machine in a trailer and together they weighed almost 5 tons! The biodiesel fuel gave at least a 10% power gain over petroleum diesel and we felt every bit of it on the mountains.

Life on the American road in the Veggie Van was a non-stop, colorful adventure. At least one out of every four people who passed us on the highway waved, honked, or gave us a big smile. We often turned our heads to absentmindedly look at a passing vehicle only to see a camera flash from the passenger's side. In rest areas and parking lots, people gathered around the van, reading its messages, taking pictures of family members next to it, and including it in their summer vacation home movies. The first question people asked us was, "Does it really run on vegetable oil?" One whiff of the exhaust was enough to convince most skeptics. Believe it or not, it does smell like french fries.

That summer, we talked with farmers who want to run their equipment on oil from the crops that they grow. We found that urban dwellers want public transport without the asphyxiating pollution. We met with CEOs, environmental organizations, and people of all ages and backgrounds. We talked to "snowbirds" in campgrounds, truckers in truck stops, and young men in fast red cars in traffic jams. We talked to students of all ages who want to study clean technologies. We talked a little and we listened a lot. We heard the voices of a proud, caring people who still love their country, their land, and their air. They want to use clean fuels in their cars and renewable energies in their homes.

The Public Responds

When the 1997 Veggie Van USA Tour officially ended in Hopland, California, the Veggie Van had been on the Today Show, Dateline NBC, Nightshift, and many other news broadcasts across the country. The Associated Press circulated an article about the Veggie Van to hundreds of newspapers around the country. Wherever we arrived people said they just read about us in the paper. The Veggie Van website logged over half a million hits that summer and continues to receive hundreds of visits a day. The website was featured in Yahoo's weekly picks and in Internet Life Magazine.

Power to the People

The 1997 Veggie Van USA Tour gave us proof that there are better ways to run cars and ultimately better ways to run our society. Every time we turned grease

Below: The "Main Reactor" of the Green Grease Machine is a converted military steam kettle. Also shown, the Yanmar Diesel generator which runs on biodiesel to power the Green Grease Machine.

into clean fuel, we proved that we can create clean energy resources using our current technology. Our goal is empowerment of ourselves and others through education and information. We wrote the book, *From the Fryer to the Fuel Tank: How to Make Cheap, Clean Fuel from Free Vegetable Oil*, in response to the hundreds of e-mails, letters, and phone calls we received requesting more information about the amazing fuel made from fryer grease. This first book about biodiesel available to the general public gives simple, easy-to-follow instructions for making fuel from vegetable oil. Everyone aged six to one hundred and six will find this book a humorous and insightful look into vegetable oil power, renewable energy, and how to make cheap, clean fuel from free fryer grease.

The Veggie Van Rides Again!

The Veggie Van is currently voyaging to schools to show young people that renewable energy such as biodiesel fuel and solar power are easy to use and good for the environment. The response from kids of all ages has been a big "thumbs-up" for the plant-powered vehicle.

Meanwhile, preparations for this year's "Veggie Van Grease'n'Go USA Tour" are underway. Starting in June, the fryer grease hits the Veggie Van fuel tank and the tires hit the road in another exciting cross-country adventure. This year's USA Tour goals are to have fun, make tons of fryer fuel, and show up in unexpected locations to talk to people about renewable energy. (Did we mention that the Veggie Van could show up in your home town?—send us an e-mail telling us where you are and why we should come there!)

The only part of the itinerary we are disclosing is that the Veggie Van will visit the Solar Living Center for their 1998 SolFest celebration on June 20 and 21. While the Veggie Van makes its way through the highways, bi-ways, and fast-food restaurants of America this summer, the cyber-tour will be occurring online at www.veggievan.org. Events will be announced a few days ahead of time (so you have time to tell your friends that the Veggie Van is coming to your town). You can follow the adventures, trials, and tribulations of the Veggie Van by watching the site for our daily digital updates. The Cyber-Grease'n'Go Tour will feature stories, press, and, of course, pictures of the clean-burning odyssey as it unfolds.

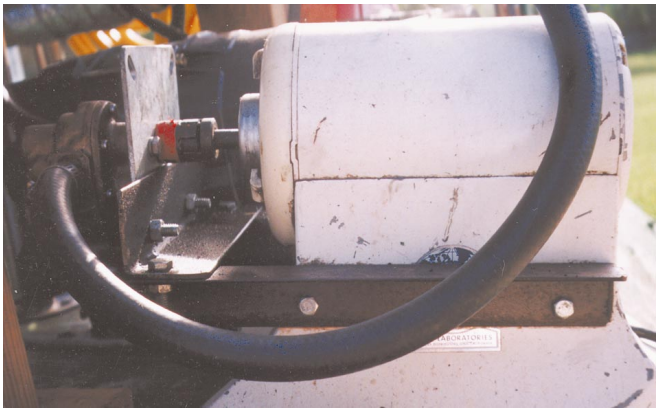
Above: Authors Joshua and Kaia Tickell display samples of their homemade biodiesel.

Access

Authors: Josh and Kaia Tickell are available to visit schools and events with the Veggie Van. c/o GreenTeach, 15 Paradise Plaza, Suite 311, Sarasota, FL 34239 • Fax: 813-354-2377 • E-Mail: van@veggievan.org • Web: www.veggievan.org

From the Fryer to the Fuel Tank is available through the web site or by calling 800-266-5564

Below: A converted Champion juicer motor serves as the main pump for the system.



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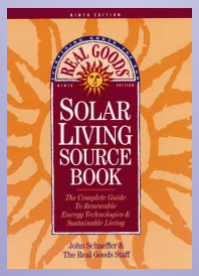

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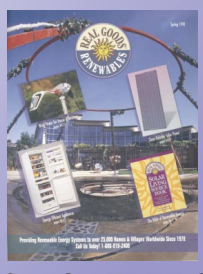

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The Three Solar Musketeers of Maine

Fighting to Reinstate Net Metering

Peter Talmage

William Lord

This is the story of the death of net metering in Maine, the swift engagement to resurrect it, and the final battle to modify it for the New Millennium. It is also the story of three PV advocates who spoke out at public hearings, were heard by responsive state regulators, and in the process significantly influenced the outcome of a struggle that threatened to push Maine back into the Ice Age of net metering.

A Death Barely Noticed

In August of 1997, a notice arrived at my home from the state Public Utilities Commission asking for comments on how to proceed regarding various issues in light of the new electricity restructuring bill that had recently been passed by our legislature and signed by our governor. The PUC noted that the net metering portion had become an option for the utilities, thus eliminating the requirement that utilities enter into such net billing contracts. Mandated net metering, which had existed for a decade in Maine, had been killed off by the state legislature without the knowledge of any interested solar parties. One word had been changed in the legislation— a "requirement" had become an "option." We were soon to see how one utility intended to exercise their "option."

The Two Musketeers

Meanwhile, in the southern Maine neighboring towns of Kennebunkport and Arundel, two PV advocates were preparing their arrays for interconnection with Central Maine Power Company (CMP).

Peter Talmage, founder of Talmage Solar Engineering, had been living quite well "off-the-grid." However, it was time for the array to grow to meet expanded energy needs. Why go intertie? There was the cost savings of not needing to acquire a new battery bank and there was the ability to share excess power with neighbors via the grid. Peter's 2.16 kW system included two trackers feeding an Omnion inverter. The panels followed the sun from sunrise to sunset—in effect raising the array to nearly 3 kW. Peter contacted CMP four times between June 23 and July 17, 1997, requesting a net billing contract. Each time he was turned down.

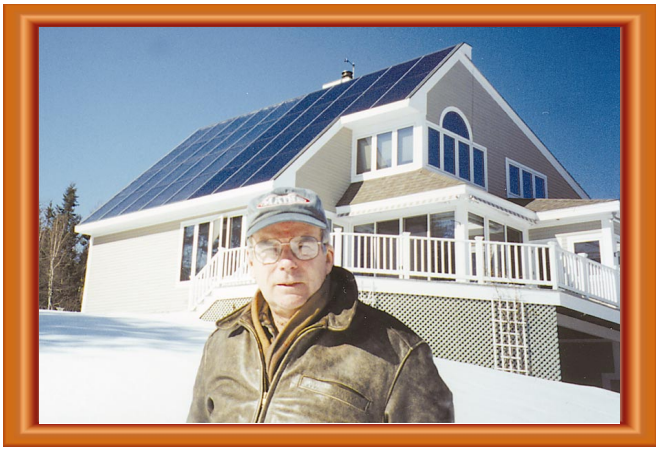
At the same time, his business partner and co-founder of the Heartwood College of Art, Naoto Inoue, was completing his rooftop solar installation on a new building designed to house art students in a dormitory setting. Atop the roof were solar thermal panels for heat and domestic hot water, plus a 4.4 kW ASE array feeding an Omnion inverter. During the summer, Naoto also requested a net billing contract from CMP, but to no avail.

CMP argued that a Federal Energy Regulatory Commission decision preempted Maine net billing rules. In addition, they cited the new legislation which did not mandate net metering contracts with small producers but gave the utility an option as to whether to enter into such contracts (in other words, veto power). They boldly stated that they would not be entering into any further net metering contracts.

The Two Musketeers Protest

Peter and Naoto were faced with the prospect of no contracts (so much for the President's Million Roofs program) and the need to acquire substantial battery banks. It also meant the increasing interest in intertie systems in the state would wither and ultimately die.

Naoto Inoue



William Lord

The Two Musketeers picked up their mighty pens (keeping their swords sheathed for a future battle) and filed a petition with the PUC on July 31, 1997, requesting intervention (the going rate for such a regulatory review is $1000 per megawatt—Peter put up his $2.16 and Naoto followed with his $4.00). The battle had been joined at a reasonable cost.

The PUC Decides—Round One

Within six weeks, the Public Utilities Commission ordered CMP to accept the Talmage and Inoue requests. Not only was CMP premature in attempting to exercise its option under the restructuring legislation (the act did not go into effect until 90 days after signing), but the PUC firmly told utilities that Maine law took precedence over any federal guidelines and new contracts must be signed through March 1, 2000.

The utility regulators also defined such home PV intertie operations as small power companies, swapping power back and forth with the utility until at the end of the billing period, when the net was determined, and a bill was prepared (retail power is 12 cents/kWh and avoided cost is 2-3 cents/kWh—any excess power generated by an intertie customer is bought back by the utility at that lower rate).

It was a win for the Two Musketeers—the PUC had reinstated net metering through March 1, 2000, when the new competitive electricity era begins in Maine. Yes, we'll be able to buy our power from Texas or Florida, though it's more than likely that we'll stay with our "green power" from the Pine Tree State's many dams. Those dams, however, will likely be owned by Florida Light and Power—but that's another story.

The Battle for the 21st Century—the Musketeers Become Three

Even though this was an important decision—reinstating net metering—the question had to be asked: Would you buy and install a new intertie PV system, knowing that by the year 2000 your net metering contract would evaporate? Not likely.

On November 6, the PUC sent out a rulemaking notice calling for a public hearing. About net metering, it said:

"...an existing practice that facilitates the use of small, renewable generating facilities...is not one that should be disrupted solely as a result of industry restructuring."

That was an incredibly encouraging statement just months after the legislature had created the ominous "utility option."

And so I joined the Musketeers—to preserve my own existing contract with CMP which would end at the stroke of midnight, December 31, 1999, and to assure potential PV converts that a similar arrangement would be available to them after the millennium. My solar home in Cape Porpoise has a 4.2 kW array (ASE panels) with a Trace inverter as well as solar thermal panels integrated into its roof. On an annual basis, the PV array handles our electrical load and the solar thermal panels produce an estimated 75% of our hot water and heating needs.

Peter and Naoto are friends and neighbors and together, as a threesome, we focused on the post-2000 period. Their efforts against CMP had been supported by the fine work of Tom Starrs in Vashon, Washington—a PV advocate and utility legal expert. With his guidance and support, we eagerly responded to the PUC's call for comments. Peter and Naoto filed a written statement and I journeyed to Augusta on December 12, 1997, to appear in person.

The Public Hearing

At the public hearing, I was the only party to appear without a lawyer. I called on the commission to take a "do away with" approach:

1. Do away with two meters—many states use one bi-directional meter only.

2. Do away with complex billing—eliminating one of the utilities' constant complaints. We proposed an annual billing procedure—allowing excess generation to be credited from month to month until the end of a 12 month period. This would eliminate the need for the utility to buy back our excess power at "avoided cost" each month. We'd receive one bill per year. If at the end of the year, we had consumed more grid power than we exported, we'd pay the retail rate of 12 cents/kWh. If there was a net excess generated, we'd give that back to the utility WITHOUT COMPENSATION!

Had we lost our minds? Perhaps, but our philosophy has always been that home, farm, and small businesses usually put up PV panels to offset their annual power consumption, not to make money selling any excess back to the utility. Yes, we would sacrifice our "profit" (small producers realize this is a few dollars per month at most) but we hoped to gain the energy community's understanding support. A quick calculation showed we'd actually be ahead of the game financially under this new system since our surpluses would accumulate instead of being "netted out" each month.

3. Do away with power company imposed interconnection requirements, fees, and facilities charges. Inverter standards now comply with the National Electrical Code and use UL listed components. Ideally, interconnecting a solar electric system or a wind turbine to the grid should be no more complicated than obtaining new electricity service.

Our approach was simple: Do away with complexities and unwarranted costs for both parties.

My physical presence added a personal touch to the proposals and caused the commission to spend additional time on our agenda, not the power companys'. In addition, I was present to rebut such casual CMP remarks as, "we don't want the linemen electrocuted." I likened the inverter to a vacuum cleaner—needing power to operate. Without power, the linemen were as safe from electrocution as they were from being sucked up by an unplugged Hoover.

The PUC Decides—Round Two

The PUC considered the pubic comments for three months, and then on March 10, 1998, issued a policy statement dealing with net metering. When finalized, it will be a complete win for PV advocates in this corner of the nation!

To quote from their release:

"The new net billing provision that we anticipate including in the renewable resource rule will be the annualized methodology, proposed by Messrs. Talmage and Inoue and supported by Mr. Lord and the Public Advocate, in which usage and generation are netted against one another on a rolling basis for a 12 month period."

Yes, we would return any excess to the utilities without compensation. Further, Central Maine Power has been attempting to restrict any future net billing contracts to households only, but the PUC said any individual, farm, or business could avail themselves of the new policy as long as their facility was under 100 kW.

As a matter of policy, the PUC has taken our net metering section out of the rules governing the sale of power to utilities and incorporated them into a "rule generally governing the promotion of renewable resources in a restructured industry." In other words, there will be no further negotiations about net metering in Maine.

The Three Musketeers Stand Down, But Remain Vigilant

If there is one lesson we Three Musketeers have learned, it is to stay alert to what your state legislature and regulators are doing as they restructure your state's electricity laws.

It's not paranoia to warn about the risks of inattentiveness. It's also not Pollyanna to look at this transition period as an opportunity—an opportunity to make net metering an integral part of your state's energy portfolio in the 21st century. The battle was swift and successful. We hope your efforts in your state will yield similar results.

Access

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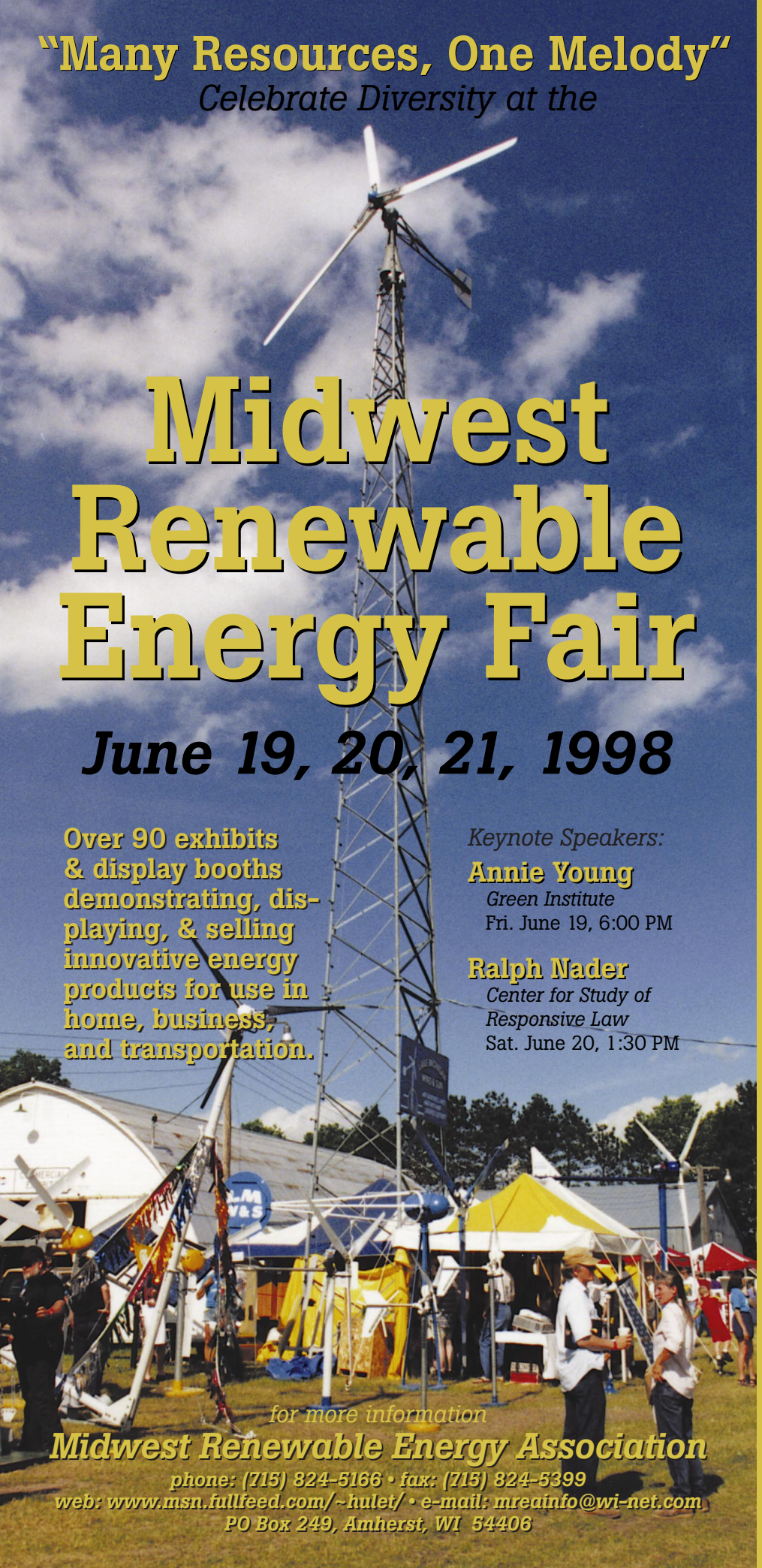

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User-Friendly Electric Cars

Shari Prange

Last time, we looked at an electric car conversion from the perspective of the mechanic. We talked about ways to make it easier to build and easier to work on later. This time, we'll take the point of view of the driver. There are things you can do in the conversion process that will make the car easier and more pleasant to use.

A Balancing Act

We touched on weight distribution last time, but it's worth mentioning again. If possible, measure front and rear axle weights on the car before conversion. You can do this at a public scale which may be available at a feed store, quarry, or public landfill. Drive the front half of the car onto the scale and weigh it, then the whole car, and finally just the rear half. Now try to maintain the front-to-rear ratio as closely as possible as you lay out your battery pack, and be sure to distribute the weight evenly from side-to-side. You also want to keep the weight as low as possible and as much as possible between the axles. Of course, the ideal arrangement would be putting all the batteries under the floor of the passenger compartment, but this just isn't possible in real life conversions. So just try to get as close to this ideal as you realistically can. This is essential to the handling of the car.

A car that is weight-biased toward the front or rear won't respond properly to steering. "Understeer" occurs when you turn the wheel but the car tends to keep going straight, so you have to turn the wheel more. Most street cars are deliberately built with a little understeer because this is considered safer than full responsiveness. It means that the car stays pretty stable, and doesn't veer wildly with a small twitch of the wheel.

However, serious understeer is dangerous. This is similar to what happens when the car hydroplanes on wet pavement or skids with locked tires. You turn the wheel but the car keeps going straight, maybe into an obstacle. This can also happen if the car is badly balanced, especially with too much weight in the rear.

"Oversteer" means the car turns too much. In fact, in extreme circumstances, it wants to spin completely around. This can also be the result of bad weight distribution. In an emergency situation, a spin can happen too quickly to prevent. If the weight is biased towards the ends of the car, outside the axles, this will further magnify handling problems. In normal driving, it would be a mild irritation. In an emergency, it could be deadly.

In Easy Reach

All electric cars should have a manual emergency disconnect switch, such as a circuit breaker, within easy reach of the driver. This is in addition to the ignition key. When placing this switch, think about what would be the most logical and easiest position for it in use. For example, a circuit breaker looks like a big light switch. Therefore, it makes sense for up to be "on," and down to be "off." In an emergency, you don't want to have to stop and think about it. If the switch is mounted horizontally, sit in the driver's seat and try out the different motions. Which would be quicker and easier to do in a hurry, slap it toward you or push it away?

Okay, Smart Guy, Now Reset It

Sometimes, the actual switch is mounted elsewhere in the car, and only the control to flip it is near the driver. In this case, you need to consider what is required to reset the switch after it has been thrown. One fellow decided to cleverly use a nice red heater lever next to the driver's seat to throw his remotely mounted circuit breaker. The flaw in his design showed up when the car was transported on a flatbed to a rally. Once loaded on the truck, another fellow (unaware of the lever's function) pulled the lever up, tucked a note under it, and pushed it back down to hold the note securely. When the car got to its destination it wouldn't start—absolutely dead. After much back and forth phone analysis, the tripped circuit breaker was deduced. Unfortunately, resetting the breaker required crawling under the car. The poor guy to whom the car had been delivered had two bad knees, and almost couldn't do it. The moral is: resetting the breaker shouldn't be so complicated it would be a hardship alongside the road in the rain.

I Can't Believe It's Not Butter—Er, Gas!

This leads to the broader topic of "transparent operation," which does not refer to radar invisibility. In use, the car should resemble a "normal" car as much as possible. An EV will have a few differences from an internal combustion car, such as the aforementioned circuit breaker and some different gauges. However, you should try to keep the car's "strangeness" to a minimum. Any driving procedures that feel odd will put

off non-EV people to whom you proudly display your car, and will make it harder if you want to sell your car someday. Even if you become accustomed to its quirks, your reflexes might not respond properly and quickly in an emergency. An extreme example was a car with an experimental regenerative braking system. To use the regen, you had to flip a switch and press down on the *throttle*. Talk about scary!

Don't introduce a lot of unnecessary switches and gauges. Follow the KISS principle: Keep It Simple, Stupid. When you do need to add something, try to make its operation as intuitive as possible. For example, I once drove an EV with a dash toggle for "forward" and "reverse." Unfortunately, up was "reverse" and down was "forward," the exact opposite of what my instincts told me. The same car had a digital "fuel gauge" that counted UP to some arbitrary number as you consumed energy. It was very confusing.

Above: It's easier, at a glance, to register the needle position of a gauge than to interpret a digital display.

Needles And Numbers

This leads to the subject of gauges. There are many things you can do wrong with gauges, and all of them have been done often. Let's start with digital vs. analog. In a "car of the future," it's very tempting to use high-tech looking digital gauges. Don't. The first reason is that they can be very hard to read. LEDs and LCDs both wash out in direct sunlight, and LCDs aren't backlit at night. Also, when the car is accelerating, numbers may change too quickly to be readable. The second reason is that digital gauges make you work harder. Your brain can quickly register a needle position as "okay" or "not okay." Numbers require interpretation and actually use a different part of your brain.

It is also more difficult on a digital gauge to quickly spot which direction it's moving, how quickly, and if it's speeding or slowing its movement. Major auto manufacturers dallied briefly with digital dashes, and

Above: The external charging port is much more convenient than the original Porsche 914 gas fill under the hood.

dumped the idea after overwhelming customer dissatisfaction. Look in the cockpit of an aircraft sometime. Even if there are digital gauges for detail, there is an analog gauge beside it for quick reference. Even if the gauges are displayed on computer screens, they are analog faces. There is a good reason for this. It involves ease of use and, again, safety in an emergency. It's also important to use automotive spec gauges. Meters designed to be used on stationary electronic equipment will not hold up to the temperatures, humidity, and road vibrations of a car, and probably aren't backlit. You will not be happy. Another gauge issue is placement. You want to get them as close to the driver's line of sight as you can. The more you have to take your eyes away from the road, the less safe you are.

Making It Go

People are often tempted to eliminate the clutch from a manual transmission conversion. While it is easier to

Above: Like a big light switch, for this circuit breaker "down" means "off".

shift an EV than a gas car without a clutch, it's even easier to actually use the clutch. There was recently an extensive discussion among EVers on the internet regarding this very subject. Even those who liked their clutchless EVs admitted that driving them smoothly required much practice and tricky technique. This could render your car undriveable by others. An EV is already easier to drive than a gas car. You don't have to use the clutch at all when you brake to a stop, and you don't have to worry about "killing" the engine if you bobble the shift a little.

Making It Stop

Your conversion will weigh more than it did as a gas car. As a driver, you need to feel confident in your ability to stop. If your chosen donor model comes in two versions, with or without power brakes, take the one with. If you have one without, see if you can add a scrapyard power brake unit. Then use an electric vacuum pump and reservoir to provide the "power." Use heavy duty metallic brake pads and shoes. You might want to investigate replacing drums with discs, or replacing discs with larger discs from another model in the same automotive family.

Charging It Up

Placement of the charging port is important. This is something you will have to deal with every day. Most conversions do the cute thing and put it in the former gas fill port. This is usually fairly convenient, but not always. Think about the outlet into which you will be plugging. Is it at the back of the garage? Is your gas fill at the back of the car? Do you want to back into the garage? If you decide against the gas fill option, think about easy access. If you have to open the trunk or hood to reach the charging port, that's one extra hassle. If you have to leave the lid open, you will be reluctant to charge in the driveway at Aunt Sally's house while it's raining. Some people will go to great lengths to cleverly hide or camouflage the charging port, putting it under a flip-up license plate or some such. Think about plugging it in while in your dress clothes. Think about your back and chiropractor bills. Bending down is bad enough, getting down on your knees is too much. Be sure you can see and reach the charging port from a comfortable standing position.

Dear Diary

Keep a daily log of your travels. It doesn't take much. Just jot down the starting mileage and state of charge, destination, and ending voltage and state of charge. This will make it easy to spot developing problems early. Most of us tend to drive the same routes day after day. If you go by the feel of the car alone, you may not know you have a problem until it impinges on your daily commute. However, if you keep a daily log you will notice if you start to come home from work with less voltage than usual, even if the car feels fine. Then you can look for the problem. It might just be a slow leak in your tire, but it could be a battery going bad. With a log you can catch it early, before it leaves you stranded or damages the rest of your pack.

User-Friendly Means Safe

You may have noticed a common theme through many of these points. While these suggestions make the car easy to use, they make it safe, too. This is not a coincidence. If procedures are difficult or irritating or require too much concentration and effort, they may be ignored or may not come quickly and naturally enough in an emergency. A vehicle that is easy to use is not only more pleasant and easier to sell, it is also safer.

Access

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Mike Brown

Question: I have just purchased a used EV that hasn't been charged in about a year. How do I go about reviving the battery pack?

In the EV world, no matter where the conversation starts, sooner or later it drifts back to batteries. The same is true with this column. Although we have covered how to find a bad battery in a pack and what to do about it in *HP* #57 and treatments for sulfation in *HP* #58, we haven't exhausted the topic.

How successful any revival is going to be depends on several factors. Was the pack fully charged before it was left to sit? A battery pack left sitting will self-discharge over time. The higher the voltage at the start of the period of inactivity, the better the batteries' chances of survival are. With flooded batteries, are the plates still covered with electrolyte? Batteries with plates exposed to the air may have a limited future.

The age of the pack when it went out of service will affect the amount of useful life left in the batteries. If the pack was only one or two years old, they were in the prime of their life. They had just enough cycles to be broken in, but still with thick plates for good capacity. Every reasonable effort should be made to revive them, as they still have at least one more year of life in them. However, if the pack was three to four years old, they were nearing the end of their useful life. Even if you can get them to come up to their fully charged voltage, don't expect full range or many more cycles out of them.

Steps to Revival

The revival process has several steps that must be followed in order. Some of the steps occur before the charger is hooked up and turned on. The first step is a physical examination of the pack. Are the battery interconnects clean and tight? Clean any corroded connections.

The second step is checking the electrolyte level. The important thing at this time is not the amount of electrolyte above the top of the plates, but that all the plates have SOME over them. If so, leave the level alone. Water should be added to batteries only after they have been fully charged. If there are plates showing, add only enough water to cover the plates before charging and finish adding water to the batteries after charging. Note which batteries had exposed plates, as these will probably show up as weak batteries in use. This is due to oxidation, which occurs when the plates are exposed to air.

The third step is a series of voltage checks. First check each individual battery voltage and record it on a sheet or battery layout diagram, identifying each battery by either its number or position in the layout. Batteries will start to sulfate if their voltage falls below 1.75 Volts per cell, 5.25 Volts per 6 Volt battery, or 10.5 Volts per 12 Volt battery. Note which batteries fall close to or below these numbers on your sheet or diagram. Read the total pack voltage as well, and note this number as a starting point for the revival process.

Charge!

Now it is time to charge the batteries. Watch the pack voltage during the charging period, it should climb slowly. If you are using a 120 volt input charger, the battery pack should be fully charged after about ten to twelve hours. If you are using a 220 volt input charger, charging should take half as much time. On this first charge, it is probably a good idea after the eighth hour to periodically check pack voltage and overall conditions. Check for an intense, sharp odor indicating a shorted cell, water discharge from the vent caps, and any sign of overheating. A slight, sweet sulfur smell is normal during the last stages of charging.

At the ten hour mark, start paying close attention to pack voltage as the batteries should be approaching the fully charged point of 2.5 Volts per cell. To get the full pack voltage under charge, multiply 2.5 times 3 (6 Volt batteries) or times 6 (12 Volt batteries), times the number of batteries in the pack. If, after twelve hours, the pack hasn't reached full pack voltage under charge, check each battery to see if there are any that aren't taking a charge. If all the batteries' voltages are fairly even, continue charging until full pack voltage is achieved. A neglected pack will often take longer to charge the first time than a pack that has been in use. If you are using a 220 volt charger check the batteries at the fourth, fifth, and sixth hours of charging.

Drive!

After the batteries are charged, unplug the charger and drive the car around the block to take off the surface charge. Then check individual battery voltages again. The voltages should be within 0.05 to 0.10 Volts of each other. If all the batteries came back within this range, you are on the way to what might be a successful revival.

There is still the possibility of a failure or two further down the road, and the batteries may never have the same capacity they did before they were left to sit

dormant. The batteries should be given several shallow charge and discharge cycles with slightly increasing driving distances as a build up prior to attempting a maximum-range run.

On the other hand, if some of the batteries flunked the 1.75 Volts per cell test, had exposed plates, or failed to come up to the same level of charge as the rest of the batteries in the pack, sulfation or oxidation may be the problem.

The subject of sulfation was covered in this column in *HP* #58 and I feel that most of what I said is still true. The exception is with the electronic desulfaters. I have received some user reports showing interesting results. These units might be useful in reviving the marginal batteries or increasing the capacity of the "good" batteries.

If you end up with one or two absolutely "bad" batteries that won't take or hold a charge, a search of battery dealers or fellow EVers might turn up a source of good used batteries. It is important that any batteries added to an existing pack be of the same brand, capacity, and age. See *HP* #57 for a discussion of how to add batteries to an existing pack.

I gave the reader that phoned in this question the same information you just read, but I haven't heard any results yet. I hope this helps. Keep the questions coming in.

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Grounding Separate Structures

John Wiles

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In many stand-alone PV installations, the main ac loads for the system are located in a building or structure separate from the PV array, batteries, and the inverter. This poses the question: "How is the ac system grounded to meet the requirements of the National Electrical Code?"

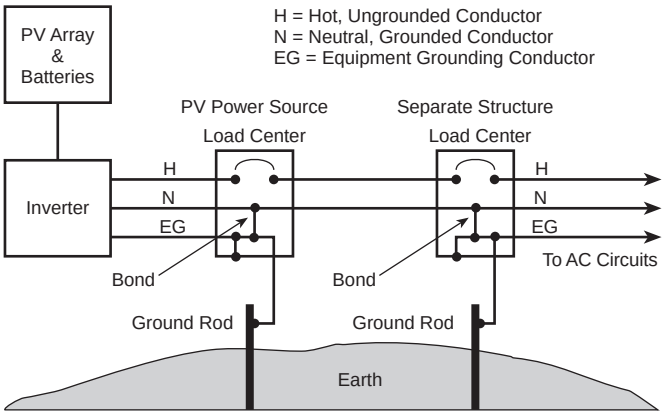
The general requirements for grounding were covered in the Code Corner column in *HP* 64 for a system where all of the sources and loads were in the same building. In this article, the requirements for grounding the ac circuits running to separate structures will be covered. In general, where the loads are some distance from the source, it is best to group the low-voltage circuits (PV, batteries, and inverter) in one location and then run the 120-volt or 120/240-volt output of the inverter to the loads at the separate structure. This configuration will minimize losses in the cables since the 120-volt ac circuits operate at lower currents than the low-voltage DC circuits. There are two accepted methods of grounding the ac circuits leading to separate structures.

Common to both methods is the requirement for a grounding electrode (e.g., a ground rod) at each structure—both the PV power source building and the structure (residence) where the distant loads are located. Grounding electrodes in both locations are required to serve as a grounding system for the equipment-grounding conductors at each location. As discussed in *HP* 64, all exposed conductive (metal) surfaces in the power system must be connected together with the appropriately sized conductors and then connected to a grounding electrode.

Method 1

The first method of grounding the separate structure is similar to the grounding used in a grid-connected home for grounding the service entrance conductors.

At the PV/inverter location, there is a bond or connection between the ac neutral conductor on the output circuit of the inverter and the grounding system leading to the grounding electrode. This bond is usually made in the load center or circuit breaker box that is used to provide overcurrent protection for the inverter output.



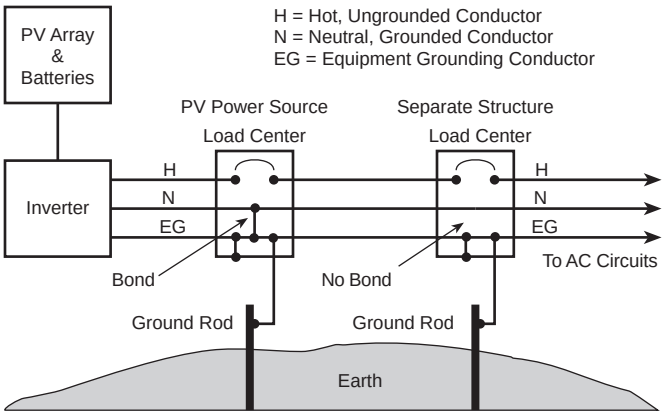
Only the ungrounded (hot) and neutral ac conductors are run to the separate structure. The equipment-grounding conductor (bare or green wire) is not connected between the two locations. In a 120-volt system, there will be only two conductors (one hot and one neutral) connected between the two locations. In a 120/240-volt system, there will be three conductors (two hot and one neutral) connected between the two systems. The two grounding electrodes must not be connected together by a separate bonding conductor.

At the separate structure, the neutral conductor is again bonded or connected to the grounding system. As mentioned above, this is identical to utility practice where the neutral service entrance conductor is bonded to ground at the utility transformer and again at the residential load center. Only ungrounded (hot) and neutral conductors are brought to the house.

Method 2

In the second method, the neutral conductor is bonded to the grounding system at the inverter location, but is not bonded to the grounding system at the separate structure. A separate, isolated (insulated) bus bar is required so the neutral conductors can be isolated from the grounding system. In this method, shown in Figure 2, an equipment-grounding conductor is connected between the two locations and run along with the hot and neutral conductors. In a 120-volt system, there will

be three conductors between the two locations (hot, neutral, and equipment-grounding). In a 120/240-volt system there will be four conductors between the two locations (two hot, one neutral, and one equipment-grounding).



Sizing the Equipment-Grounding Conductor

The equipment-grounding conductor should be sized according to the requirements of Table 250-95 in the NEC, which is based on the overcurrent device protecting the circuit. For example, if the circuit overcurrent device is 60 amps, the equipment-grounding conductor should be a number 10 AWG (American Wire Gauge) copper conductor. If the circuit is a 100-amp circuit, then the equipment-grounding conductor should be a number 8 AWG copper conductor.

Changes Required for Voltage Drop

Since the distances between the inverter location and the building with the loads may be significant, many installations use oversized hot and neutral conductors to reduce the voltage drop between the two locations. To ensure proper operation of overcurrent devices in this instance, Section 250-95 of the NEC requires that the equipment-grounding conductor be oversized proportionally.

For example: A Trace SW4024 4000-watt inverter has the 60-amp ac output connected to a circuit which is protected with an 80-amp circuit breaker. From ampacity calculations (NEC Table 310-16), a number 4 AWG conductor with 75°C insulation is selected with an ampacity of 85 amps at 30°C ambient temperature. The use of an 80-amp circuit breaker, providing overcurrent protection for this conductor, would dictate a number 8 AWG equipment-grounding conductor. A very long distance between the inverter and the house results in excessive voltage drop on even this 120-volt circuit. Voltage-drop calculations indicate that the conductors (hot and neutral) should be increased in size to number 1 AWG conductors.

Table 8 in Chapter 9 of the NEC is used to find the cross-sectional areas of each of the conductor sizes. They are: 8 AWG = 16,500 circular mils(cir mil), 4 AWG = 41,740 cir mil, 1 AWG = 83,690 cir mil.

The ratio of areas between the new number 1 AWG conductor and the original number 4 AWG conductor is 83,690/41,740=2.005. The NEC requires that the equipment-grounding conductor be increased in size by this factor of 2.0. The calculation shows that the new area is 2.005 x 16,500 = 33,083 cir mil which, from Table 8-Chapter 9, is a number 4 AWG cable.

The circuit now has two number 1 AWG conductors (hot and neutral) and a number 4 AWG equipment-grounding conductor.

Additional Requirements for the Equipment-Grounding Conductor

The equipment-grounding conductor may be bare (no insulation) or have green insulation. For sizes larger than number 6 AWG, only black-insulated conductors are generally available, so the NEC allows these conductors to have the exposed insulation marked with a green tape at each termination and at other places where the cable is accessible.

For ac circuits, the equipment-grounding conductor must be run in the same cable, conduit, or raceway as the current-carrying conductors.

An Aside for DC circuits

The same procedure for oversizing equipment-grounding conductors for voltage-drop considerations in ac circuits can be used for DC circuits.

Summary

In stand-alone PV systems, where the ac load circuits are some distance from the ac source (the inverter) in separate buildings or structures, there are two options for correctly grounding the system. Of the two grounding methods presented in this article, the first method uses one less conductor and is therefore less expensive. Other design considerations, such as using oversized conductors to reduce voltage drop and losses, require that the equipment-grounding conductor also be oversized.

Questions or Comments?

If you have questions about the NEC or the implementation of PV systems following the requirements of the NEC, feel free to call, fax, email, or write me at the location below. Sandia National Laboratories sponsors my activities in this area as a support function to the PV Industry. This work was supported by the United States Department of Energy under Contract DE-AC04-94AL8500. Sandia is a multi-program laboratory operated by Sandia Corporation, a

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Beyond Net Metering

Don Loweburg

In the last two issues of *Home Power Magazine* there have been constructive critiques of current and pending net metering laws. In *HP* #63, Jeff Klein's letter pointed out that most net metering laws were flawed because they did not include wind and hydro sources. Jeff also said that many grid connected PV systems were installed by homeowners who did it for environmental or hobbyist reasons, not economics. *HP* #64's Power Politics column makes some of the same points and questions a pending change in California's net metering law that gives away any net excess power to the utility or provider.

A Second Look

Though it seems galling to give power away to the utility, this is not such a bad deal. Let's examine the economics. In addition to a zeroing out of net excess energy is a change from a monthly to a yearly accounting period. Monthly summer excess credit can be carried forward. Unless the array is oversized (unlikely), winter months will allow the excess credits to be used up. The customer-generator receives retail value for any monthly excess power produced. The annualization period for net metered PV systems would best be timed to start in the spring. Under the old method, monthly accounting of excess power would only yield avoided cost (wholesale, about 2 cents per kWh) and monthly settlement would, at best, be a couple of dollars.

It's Worth More

Should the RE generator get more than retail for clean power? IPP thinks so. In Europe, another approach called rate based incentives has been used, yielding owners of PV generated electricity around 40 cents per kWh. Some of those programs were discussed a couple of years ago in this column. Unfortunately, only one such program exists in this country: in Ashland, Oregon. The politics and energy consciousness of Europe and the United States are different.

Pimples and All

Should hydro and wind be eligible for net metering treatment? IPP thinks so, yet net metering legislation that includes wind and hydro is often blocked by utility lobbyists. California's proposed revised version contains important changes annualizing the netting period to improve the economics for the system owner. It can be used as a model in other states and for federal implementation. IPP thanks all members of the RE community for the tremendous amount of work expended to date.

Where Do We Want To Go?

What does a "whole loaf" look like? Richard Perez's vision of energy farming oft mentioned in this magazine is what IPP wants to see too: any renewable energy (RE) resource deployed locally. These "farms" (of all sizes) would produce excess energy that could be sold at a fair price in a truly competitive energy market. This is the vision of a fully developed system of distributed generation based on RE. To quote Amory Lovins, this is nothing less than the "withering away of the utility."

How Do We Get There?

Net metering is a first step. It establishes grid access for small scale customer-generators. Interconnection standards need to be uniform and fair. These standards must be established by independent agencies. Inspection and compliance certification must be conducted by independent local authorities. Equipment manufacturers must build safe equipment with proper protection features built in. System designers and installers must be qualified and understand the basics of electrical safety and trade practices.

Let's Get Weird

Imagine this twisted scenario of a hypothetical highway system. The road builders write the rules for using the road. Only large trucks belonging to approved companies are allowed to use the roadways. No cars or motorcycles are allowed. The road builders and maintenance crews also patrol and write tickets and remove "offending" vehicles from the road. The road builders collect huge amounts of money from the beneficiaries (users) of the road and spend it lobbying and advertising that this is the best and safest structure for all. The public buys it lock, stock, and barrel and if challenged, says, "You can't buck the road builders."

The highway system is, in fact, not like this. Safety, access, rule enforcement, building, and maintenance are all handled by independent entities for the benefit of the public. The highway system serves a common carrier function. The transportation system is open to all. Shouldn't the distribution of electric energy be just as open? IPP thinks so. The public benefits of open commerce in energy will be just as important as they are for goods, services, information, and entertainment.

Buyers Wanted

Equally important is the development of a market for "green energy." Consumers must be educated (sold) about the value of RE. James Udall's article in *HP* #64 does a great job discussing the question of value versus cost. When people perceive value, they will pay for it. The low price for commodity or bulk power is a fiction based on hidden externalities. Part of marketing green power will be to expose those hidden externalities while demonstrating the value of RE.

Nuts and Bolts of Selling Power

How would RE farmers sell their excess power? In the past, the cost of meter reading, maintaining accounts, bookkeeping, and check writing have been impediments to small energy producers (to say nothing of miserable "avoided cost" pricing). In the near future, a natural alliance between RE farmers and green marketers will develop. It is reasonable to assume that RE farmers will want to purchase power when they need it from other renewable sources. The marketers will act as brokers. The key here is that the transaction costs must be low. The use of the Internet and electronic metering will keep those costs very low. Expect electronic meters to become cheap. Each meter will be programmed with the equivalent of a Personal Identification Number (PIN). The marketer handling an account can pole the PIN on a real time basis. Consumption and production can easily be accounted for on a real time basis. The RE farmer could shift loads to favorable times while making excess power available for sale at times of peak rate. Buy low, sell high! Price signals are available in real time too, and the whole process could be handled by almost any personal computer. Renewable energy has now gone beyond net metering.

Will We Get There?

IPP thinks so. It will take both technological change (lower costs, etc.) and political change (maybe consciousness is a better term). Phasing out the burning of carbon will also happen. Carbon is much more valuable as a building material than as a fuel. Are we still arguing about climate change? Remember the Carboniferous Age? Is that the Pacific Ocean coming in your window?

Californians Strike Back

Californians Against Utility Taxes (CUT) have completed the final stages of a petition drive to place an "anti-nuke bailout" initiative on the next ballot. Among the goals is an attempt to reverse the $28 billion nuclear bailout that is contained in the state's restructuring law. This "largest corporate welfare package in California history" will cost every California family $2,000. Hopefully Californians will join the citizens of Massachusetts in their success at getting an initiative on the ballot.

Interconnection Standards

The IEEE Working Group developing P929 (*Recommended Practice for Utility Interface of Photovoltaic [PV] Systems*) was to meet in late April and hopefully reach a consensus. The remaining issue is what a "non-islanding inverter" must do (or not do). If that can be determined, then there is general agreement among the members that the "visible physical disconnect" presently mandated by many utilities would not be required.

Slow Learners or Just Don't Care

Pacific Gas and Electric Company based in San Francisco, California, would rather spend money on advertising than get their act together. In May of 1996, *The San Jose Mercury* newspaper did an extensive series of articles detailing how PG&E had cut tree trimming and other preventive maintenance budgets while simultaneously giving big bonuses to top execs. The series was prompted by a high number of power outages throughout northern California. The PUC attributed the outages to poor maintenance. During the summer of 1997, a number of fires were attributed to a lack of tree trimming. In one case, a fire near the town of Rough and Ready was determined to be due to criminal negligence on the part of PG&E. In the April 10 *San Francisco Chronicle* appears an item titled, GUILT BY ASSOCIATION: "Pacific Gas and Electric Co. will be fined for letting an affiliate use its name and logo in ads without clearly telling readers the company wasn't the

familiar PG&E, the state Public Utilities Commission said yesterday. The PUC said PG&E Energy Services, an unregulated energy provider and affiliate of the utility, broke the rules by writing illegible disclaimers—in small type, running vertically up the side of an ad, and in colors that did not stand out from the rest of the ad—in several newspaper ads." This is a blatant abuse of market power by the utility. Even if they completely changed the company name, the affiliate still represents an abuse of market power since the ownership remains with the parent company. Remember, the parent company is receiving a massive bailout from the rate-taxpayers. These phony "competitive" affiliates shouldn't fool anyone. So, watch out, they will be knocking on your door offering "green" energy and services.

Net Metering Update

Tom Starrs, a national leader and authority on net metering legislation, shares some recent good news with Home Power readers.

(1) The Clinton Administration's restructuring plan (available on the DOE web site) calls for national net metering and standardized interconnection for all renewable generating facilities 25 kW or smaller. No specific bill language yet — and as we all know, the devil is in the details.

(2) The National Association of Regulatory Utility Commissioners (NARUC) passed a resolution urging state commissions and legislatures to adopt measures to make net energy metering available to small-scale renewable generating facilities, and requesting Congress and the FERC to identify and remove any barriers to state implementation of net energy metering.

(3) There were important pro-net metering decisions in Maine (favorable rules for implementing net metering under retail competition); Iowa (Iowa Utilities Board abandons proposed rulemaking that would have abolished net metering); and New York (Public Service Commission issues broad ruling on net metering implementation, rejecting utility indemnification and insurance requirements, and rejecting interconnection requirements beyond those already negotiated).

(4) Governor Locke signed Washington's net metering bill into law on Friday, April 3. This is arguably the best net metering law in the country, for the following reasons:

- It extends net metering to solar, wind, and hydro (many recent laws have been solar-only);
- It applies to all customer classes, and to facilities generating 25 kW or less (other laws are residential-only, or have a lower 10 kW limit);
- It allows month-to-month rollover credit for any excess generation (only New York has this requirement, though Maine is considering it); and
- It specifies uniform interconnection requirements based on recognized national standards (only Maryland and Nevada have similar requirements, which reduce the utilities ability to 'gold plate' interconnection requirements)."

There's More

IPP member Andrew Perchlik shares this good news from Vermont. "I am happy to announce that H605, Vermont's net metering bill passed! It is now waiting the Governor's autograph which is 99% guaranteed. Due to Vermont's rural farm culture our net metering bill is a bit different. The law allows businesses and residential customers to establish intertied systems of 15 kW and less, but farms are allowed to go up to 100 kW. This allows farms that have or will have methane generators (created by anaerobic digestion of ag waste) to take full advantage of that technology. Other highlights are: eligible systems include PV, wind, fuel cells running off a renewable fuel, or a farm system generating electricity from anaerobic digestion. Excess power generated by the system is credited to next month's bill. Any excess left at end of year is granted to the utility. Utilities must provide intertie on first-come, first-served basis until the cumulative generating capacity of net metering systems equals 1.0% of the utility's peak demand during 1996."

And in Oregon

Oregon SEIA and others are working on net metering. Oregonians, this is your time. If you have not already gotten involved, contact the Oregon Solar Energy Industries Association.

A Blatant Plug

A just published 1997 Special Issue of *The Energy Journal*, International Association For Energy Economics (IAEE) is devoted wholly to distributed generation. The special issue titled, *Distributed Resources: Toward a New Paradigm of the Electricity Business* contains nine articles exploring the many aspects of this topic. Setting the tone, the introduction begins, "Distributed Resources (DR) is an intriguing subject. It was certainly instrumental in creating the electricity industry at a time when transport costs were simply unbearable. Rejected later by those companies that it helped create, DR is now staging a come back."

Jay Morse, a California PUC regulator authored one article, "Regulatory Policy Regarding Distributed Generation by Utilities: The Impact of Restructuring"

which examines DR issues from a regulatory point of view. He first looks at DR within the context of the integrated utility of the past and then re-examines the issues for the restructured electric utility of today. The outcomes are quite different. Highly recommended reading.

Hit Piece
RE must be making the Carbon Cartels nervous. For a really bad time, read the March 9, 1998, article in Forbes Magazine by Kelly Barron. The title, "I'm greener than you—Solar panels on roofs are due for an encore. Same hype, same lousy economics" jump starts the reader either to nausea or reactionary glee. The article quotes four members of the PV industry in a context that is very unfriendly. It's hard to believe they would knowingly contribute to such a nasty article. Guys, please tell me you were tricked! Thanks to IPP member Allen Carrozza.

There is no doubt that oil, gas, and utility lobbyists are going after renewables. Check out the "Sustainable Energy Coalition Update," it's full of important stuff. And please send publisher Ken Bossong a donation.

IPP Online Soon
IPP member Bill Lord has offered to design and host an IPP web page. Bill, thank you very much. The site will include a statement of purpose, a list of members with access data, IPP Logos for downloading, the legal status for RE systems in various states, a list of states in net metering flux with access to organizers, and a summary of PURPA, FERC, and what all this means to small RE producers. The IPP web site can be a national forum and organizing focus point for small scale RE producers.

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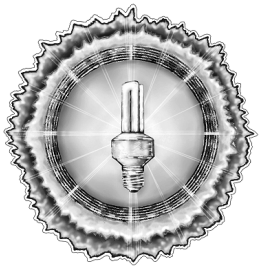

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Regulatory Adventures & the DC GFCI

Drake Chamberlin

For over two decades, I have been working with electrical systems. The methods required by the National Electrical Code® have always resulted in sound installations. That is, they always did until I encountered the DC GFCI (ground fault circuit interrupter). The only place that I ever found an outright dangerous item to be required by the code is in Article 690, "Solar Photovoltaic Systems."

The Dilemma

The customer's roof has the perfect solar exposure. It faces an unobstructed expanse of bright blue sky and snow covered mountains. A ground mounted array would have been shaded by a pine forest. Somewhere around half an acre of trees would need to be cleared to get a decent exposure. The NEC currently requires that roof mounted arrays on dwellings be protected by a GFCI. Until recently, none were on the market. Inspectors generally would not enforce putting something in a system that did not exist. Finally such an item was made available. It was made integrally with a specific power center. The GFCI itself retailed for around $600. (That was a far cry from the $8.50 price of an ac GFCI receptacle). A knowledgeable resource person urged us to find some other solution, and avoid the use of this device. He warned that it would be a compromise to the basic simplicity of the system. But, after much brainstorming, we decided that the roof was where the array needed to go. To put it there, it was necessary to have a DC GFCI. We bit the bullet and ordered the mandated equipment.

The Plot Thickens

The big day came when we hung the equipment on the wall. It was a beautiful system, featuring a Trace 4024 inverter. With conduit for all DC cables, the system was wired to specifications. When the main switch was closed, the inverter lit up and began producing power. The solar charging circuit seemed a bit strange. After an alarming bit of arcing, the DC GFCI finally seemed to be working properly. The system was on line. The next morning, however, a call came in, informing me that the batteries were overcharging. Dropping everything, I rushed back to the job site. Yes, the batteries were boiling away. I tried to adjust the charge controller. The readings on my meter were not at all in line with what the manual claimed they should be. A quick call to the manufacturer determined that there must be a problem in the wiring of the charge controller–DC GFCI loop. The solution was to disconnect all of the conduit and cables, take down the power center, and send it back. The system was back off line.

The Next Round

The power center came back. This time I was able to adjust the maximum charge level of the controller. The array was working great, cranking out more than its rated amperage. We were all happy. I was doing some of the final hookups, pulling wiring into the power center for DC circuits. Final touches are always a satisfying part of the job to me.

Then the excitement started. I brushed the GFCI's relay with a wire, and suddenly there was a tremendous amount of arcing. I shut down the array breakers, but the arcing didn't stop. I shut off the main disconnect, and it finally quit. The air was acrid with smoke. The contacts of the relay were pitted, but the system was still functional. I brought the system's owner to the

power room to show him what had happened. I pointed to the pitted contact, barely brushing the relay with the tip of my finger. Immediately, there was a blinding arc, and hot metal came spewing out. As my customer bolted from the power room, I shut down the system. In the aftermath, we stood in the smoke filled room in disbelief and surveyed the damage. The contacts were now ruined, and some of the wiring was singed. The inside of the power center had major soot deposits around the relay. It was a mess.

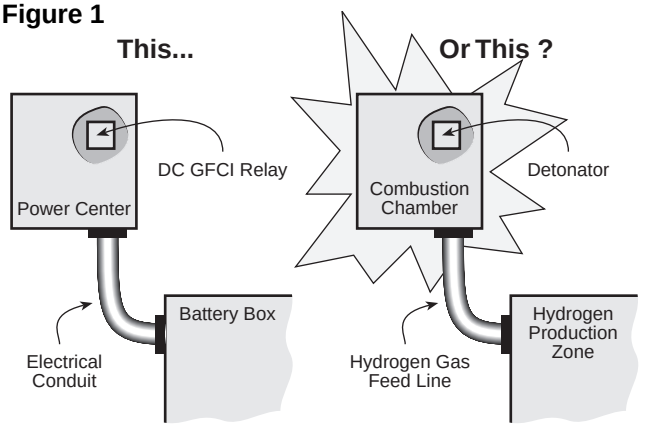
Repair of the Damage

Fortunately, the manufacturer was very helpful. We were sent another relay to install. With the new relay in, the system worked fine. We had learned to be extremely careful not to disturb the device in any way. But still all is not as it should be. The owner will not open the door to his power center. The carpenters on the job refused to use the solar system unless they were paid extra. Although the system is up and running, people are leery of it. It fully meets the solar code, complete with its built in booby trap. Yet, what happened is not all that could potentially go wrong with this setup.

Build Yourself a Listed Hydrogen Bomb

No, this is not a personal thermonuclear device for protection of your home and family. It is, however, a way to harness chemical energy from the hydrogen gas released by your batteries, to blow up your power center. The mind boggles at such technology. In areas of rigid code enforcement, exposed welding cable is no longer allowed for connecting the batteries to the power center. A "listed" cable must be run in conduit. This may sound like a good idea on the surface, but a malignant potential lurks below. The pipe from the battery box can become a "feed line" for bringing hydrogen gas into the power center. An arcing DC GFCI could easily ignite a hydrogen buildup (Figure 1). In areas where welding cable is accepted without conduit, no problem exists. Any hydrogen that happened to escape from a properly vented battery compartment would quickly diffuse.

Figure 1

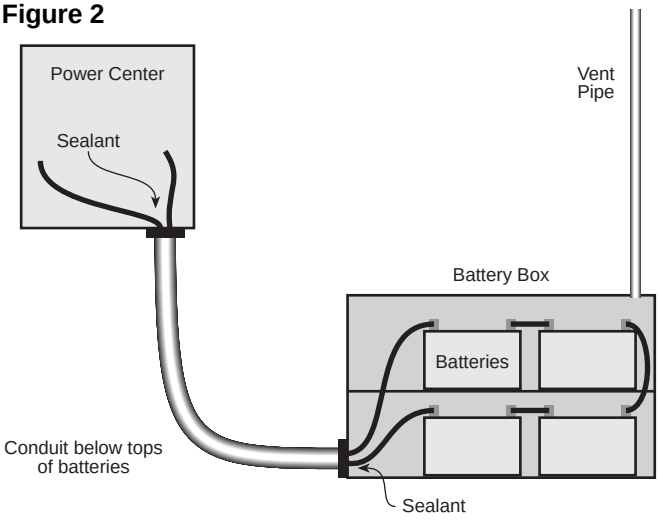


Welding cable is an excellent practical choice for an open run. It is a highly durable product designed for much more rigorous use than it is likely to encounter in a solar installation. Unfortunately it has not been "listed" for this particular purpose. This situation constitutes an institutional barrier. The right combination of paper and ink doesn't exist to allow its use even though it has performed successfully for decades.

How Not to Build a Bomb

So, it is left up to the installer to protect the system owner from these mandated "safety" requirements. There are no guarantees that a particular method will be effective. Today's efforts at preventing hydrogen migration amount to research projects. The future will show what does and does not work. It is a heck of a good idea to use double safeguards to hamper the movement of explosive gas into the power center. The obvious first step is to seal the pipe. Aerosol foam is sometimes sprayed into the conduit, from both the top and bottom of the pipe. This product seems fairly durable, but might lose its seal if the wiring is moved. Foam seems likely to be effective in the short run, but over the years might cease to function. Silicon caulk might be more permanent, but with this, it may be harder to obtain a seal. Another safeguard is to put the base of the conduit below the tops of the batteries. Hydrogen quickly rises to the top of an enclosure. As long as the battery box is properly vented, no gas should be fed into the pipe (Figure 2). Only time will tell which problems will manifest.

Figure 2



It is important for installers to make certain that there are no incidents. If power centers start exploding, it will "prove" to many that solar is dangerous. New regulations may be drafted to solve problems that were caused by solutions to non-problems that have already been forced upon us. Many of today's cities are shrouded in air pollution. On smog alert days, the death

rate from respiratory disease goes up. Our present fossil fuel technologies are killing people. Solar electric systems offer hope for keeping at least some toxins out of our atmosphere. Low voltage DC is not radioactive, and with basic equipment is easily rendered a safe technology. It would be tragic if this promise of clean energy were destroyed by a frenzy of excessive regulatory zeal. Let's stay with the real issues when making the rules.

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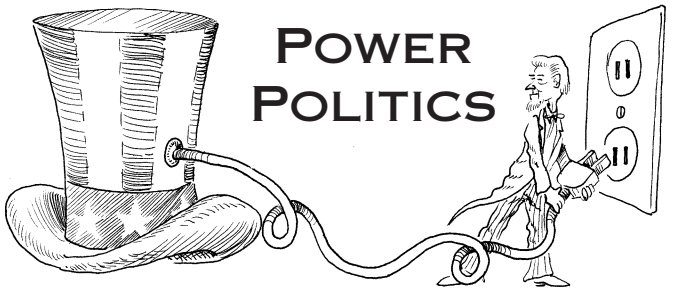

A Green Power Recommendation

Michael Welch

I am finally ready to make a recommendation for a green energy provider. It was not an easy decision, because there really is no such thing as a totally green energy provider, but also because there was not a wide variety from which to choose.

My choice is Green Mountain Energy Resources' "Wind for the Future" program. This is the same company that we at Redwood Alliance signed up with last November. It turned out that they were the most appropriate to recommend to you as well. We wanted to get some practical experience with GMER and/or others before we made our final decision. If you choose Green Mountain and mention code C029 while ordering, they will make a nice donation back to Redwood Alliance (see Access).

We still haven't gotten much practical experience with any provider because the whole thing finally got started in California on March 31. We looked forward to our switch-over from PG&E on the first, then were surprised to see that it wouldn't happen until April 24, our normal meter read date. So PG&E stuck it to us another 3 weeks (wow, those guys are tough to shake off)!

Let me take you through some of the consternation and thought processes which led to our recommendation. Finding a provider that would sell "green energy" was not difficult. At first it looked like a lot of folks would jump on the green provider bandwagon. It turned out to be only a handful and a few of those dropped out early. They did not wish to invest significant advertising and organizational capital in a project with an unknown bottom line. Sure, the polls said that 60% or more of electricity buyers would be willing to pay extra for green energy, but how much extra and at what degree of hassle to switch over?

Even Enron, one of the world's largest energy companies, pulled out of the residential electric market in mid April after investing millions in advertising. They intend to service the 30,000 households that have signed up, but no more new ones after April 30. They couldn't make any money by offering discounts over the utilities' prices and mandated savings. This doesn't bode well for residential customers under restructuring. The promise of cost savings due to competition is evaporating. This is exactly what was predicted by energy activists in California—that restructuring was designed for manufacturers and big business, not residences.

The Worst Choice is "No Choice"

There is only one good reason to switch providers—the quality of energy resource that is sold to us. My thinking has changed. Switching for ourselves should not be the primary motivation, but rather we should do it to help keep the green providers in business. In other words, when your state offers you a choice of energy providers, choose a green provider quickly, because they may not survive without signing up many customers as soon as possible. We really do need to support these budding green companies, or else grid connected folks could lose the opportunity to support clean power.

Long time readers of this column know that I am loathe to give nuclear IOUs a break, so any green provider associated with a utility immediately came under scrutiny. For example, PG&E spun off a new company called PG&E Energy Services which is now offering green energy. Unfortunately for them, I do not forget so easily how they shoved Diablo Canyon Nuclear Power Plant down the throats of California consumers, and now they want to claim their new and improved subsidiary is green? They may be selling power which may be green, but really most of this power comes from their vast, taxpayer-built, hydroelectric holdings in the Sierra Nevada Mountains. And selling some of the energy to green markets only turns their non-green supplies to an even darker shade of brown. Ditto for Earth Source (or Edison Source), a subsidiary of Southern CA Edison, responsible for the San Onofre Nuclear Power Plant.

Totally Green is Rare

It turns out that GMER is also partially owned by a

Vermont Utility called Green Mountain Power Corporation, and herein lays a bit of rub. This utility purchases power from Hydro Quebec's huge hydro plants. These plants have been built to the detriment of the traditional lands claimed by the indigenous people of Canada. The other owner of GMER is the Texas-based Wyly family, venture capital investors. So, what is the ultimate criteria from which green power provider can choose?

Totally green is best, but not easy to find. I only came across one, Sharp Energy, but I think there are some other small ones out there. 100% of the power Sharp produces comes from biomass. They use anaerobic digestion to turn swine waste into methane to power electrical generators. I am hesitant to recommend really small power producers because they may not be in the game that long. First, their primary experience is not usually in energy, and that can effect longevity. Or, they may get tired of retailing and decide to save hassle by wholesaling their power to another provider, like Green Mountain. Either way, their customers may eventually be forced to find a new provider.

From what I can figure, GMER is in it for the long run. They have become the primary and best advertised reseller of green energy for California. Their program of choice actually results in new renewable energy resources being built. For every 3,000 customers that sign up for the "Wind for the Future" program, they will commission a new wind turbine. If our energy choices result in more renewables to replace the dirty technologies, then we will have made a difference. On the other hand, this program costs somewhat more than what other companies offer and requires a time commitment. But we get what we pay for, and what I want is more renewables.

GMER has two other programs which are greenish, but not as attractive as the wind program. Other companies are out there also. Cleen 'n Green has several programs, and is the only green provider which purchases its power from within California state boundaries. Their "Green 100" program would be my second choice as a recommendation, best for folks that don't want to make a time commitment to the GMER "Wind for the Future" program.

Keep an Eye Out

Green power choices will be changing over time. One of the reasons I have not made recommendations until now is that the target keeps moving. I have been promising them for months and the deadline is at hand, so I had to take a stand. I am comfortable with my choice, but I also know that other sources of green energy could present themselves at any time. Keep looking out for new ideas. One company, Clean Power Works, which had to get out of the game early, started with a great idea. They were hoping to find land fills which were capturing the methane. I'm not clear on what ultimately happened, but I did hear that they could not come up with the startup funds. This is an opportunity for both municipalities which have land fills, and forward-looking entrepreneurs. Anyone out there?

Want to know what to look for in a green energy provider? First, what not to look for is something called the Green-e logo. This is a labeling program touted to be the only way a customer can know if an energy producer is really green. The problem is that it should really be called a green washing logo. This program is utility approved and funded by the same people that helped saddle California with its multi-billion dollar bailout of unwanted nuclear power plants. Unfortunately, the Green-e logo has gotten such a huge jump on anything else that it will likely be the only one out there.

Green-e companies which include 50% system power (the mix that has every source of power including large scale hydro, coal, oil, and nuclear) or 50% large scale hydro in their mix are allowed to use a logo that makes them appear green. GMER guarantees a maximum of 10% system power and fully expects it to be zero. Let me back-step a little, if you see the Green-e logo, view it as a clue that there just might be something there, then carefully check for true green.

Green energy should offer a large percentage of renewables, subjectively (make up your own mind) about 80%. Any hydro in the mix should be small scale (under 30 MW). System power should be for cushion only. Nuclear and fossil fuel generated power should never intentionally be purchased. A company which creates new RE should receive strong preference.

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Sharp Energy, 24684 Road 148, Tulare, CA 93274
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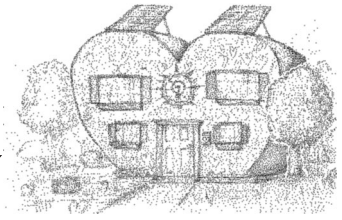
Home & Heart



Kathleen Jarschke-Schultze

I can see the sun shining outside as I work at my desk. Time to get out the solar cookers and wash them up. They'll be ready for the sun, and will make my life easier. I love having dinner ready without having to spend time in the kitchen right after work.

Models and Types

There are a variety of solar cookers available at a variety of prices. I prefer the multiple reflector models at my latitude. My absolute favorite is Sam Erwin's Solar Chef. (See H&H issues 60 & 44) Coming in a close second is the Burns Milwaukee Sun Oven. Both of these cookers are ultra sturdy and can be left out in the weather.

Box cookers with a single reflector are inexpensive, prolific and most effective closer to the equator. They are difficult to deal with in a windy area. However, they are a popular choice for a lot of people. The Sacramento Municipal Utility District in California holds a Box Cooker Marathon every year on the front lawn of the state capitol.

For a really inexpensive efficient multiple reflector cooker that you can assemble in a day from mostly recycled materials, I'd have to choose Joseph Radabaugh's SunStar cooker. Recently revised and updated, his book *Heaven's Flame* gives detailed, illustrated instructions on how to build the cooker. There is also an outline of points to consider if you are going to design your own solar cooker.

Joseph also gives cooking tips, the history of solar cooking and details people and developments in the field. My first SunStar cooker cost me $3.57 to make and my second one was only $2.50. These cardboard cookers will cook at the same high temperatures as the production model Burns-Milwaukee oven.

Lastly, there is the Parabolic cooker. I hear it is popular in India, but I have no experience with it. The parabolic cookers concentrate the heat onto a small area. They can get hot enough to pop popcorn or make espresso (I've seen it!). I am nervous about any cooker that could start a fire if it fell over, so I don't have one of those.

Getting Started

There is nothing complicated about solar cooking. Basically, you just have to jump in and do it. It's like learning to cook in a kitchen. You get better with practice.

I've heard that most people have twelve basic recipes that they cook. They may drop one and pick up another, but almost no one has the time to continually be cooking up new stuff. You can convert most of your favorites to solar recipes with a few caveats.

Pasta does not cook well in a solar cooker. You can make lasagne by not cooking the noodles first. Just put them in dry and make the sauce a little soupier. Also, you can't fry foods, although any "oven fry" recipe will work.

While any root vegetable is made for solar cooking, most above ground vegetables should just be steamed quickly in your kitchen. The exception is corn on the cob. Leave it in the husk or shuck it and place in a black cotton sock. Finally, something to do with those mateless socks.

Solar Cooking Hints

Rule of thumb: when using your own recipes, figure two times the regular cooking time, (except for the Solar Chef, which cooks in real time). Of course, occasional clouds or wind will lengthen cooking times.

Solar cooked food never gets burned onto pots. It heats evenly, without hot spots. It is hard to overcook a sun-cooked meal, (again, except for the Solar Chef). Do not put cheese on top of a casserole until you remove it from the solar oven. Then replace the lid 'til the cheese melts. Otherwise, it will have the consistency of Klingon armor.

Safety equipment for the well dressed solar cook includes sun glasses, pot holders and a hat or visor. When opening the oven, keep your face back and use potholders. Steam and heat could cause injury.

Always use lids on your pots and pans to avoid condensation which would limit the sun's rays. If using jars painted black, be sure to poke a hole in the lid before you set the jar in the cooker. Before you open the jar of hot cooked food, be sure to clear that hole so any built up pressure can escape.

If you will not be there to tend your oven, set it to focus on the sun between the hours of noon to 2:00PM. The food will be cooked and then kept warm as the sun

moves out of focus. To easily find your focal direction, first find the place in your yard that is sunny most of the day and that can be easily accessed while carrying hot pots of food. Put a stick in the ground at that point. This can be as small as a chopstick. Go out at noon and put a rock on the end of the shadow. Go out at 2PM and put another rock on the end of the shadow. Between the two rocks you will find the best focal point.

If you are cooking something large, or a lot of something, you will want to readjust your cooker throughout the day. This is done by standing behind your cooker and pointing it so that there is a slight shadow on the right hand side of the cooking area. This way, the sun will always be coming into focus, keeping the food at the maximum temperature, rather than unfocusing and lowering the temperature.

Converting Recipes

Any food you cook in a conventional oven at 350°F for one hour or more can be cooked in a solar cooker by just changing the time. Consider cooking times as an estimate; just cook it 'til it's done. Slow cooker recipes are perfect with out changing a thing. Sometimes you have to add a little more liquid, sometimes a little less. Play with it.

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Kathleen Jarschke-Schultze is out in the sun cooking and gardening at her home in Northernmost California, c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 530-475-0830 • Email: kathleen.jarschke-schultze@homepower.org or kjs@snowcrest.net

Solar Chef: 220 Southridge Way, Grants Pass, OR 97527 • 541-471-6065 • 800-378-4189

Burns-Milwaukee Sun Ovens, 4010 W. Douglas Ave, Milwaukee, WI 53209 • 414-438-1234
FAX 414-438-1604

Box Cookers International, 1724 Eleventh St, Sacramento, CA 95814 • 916-444-6616
FAX 916-447-8689

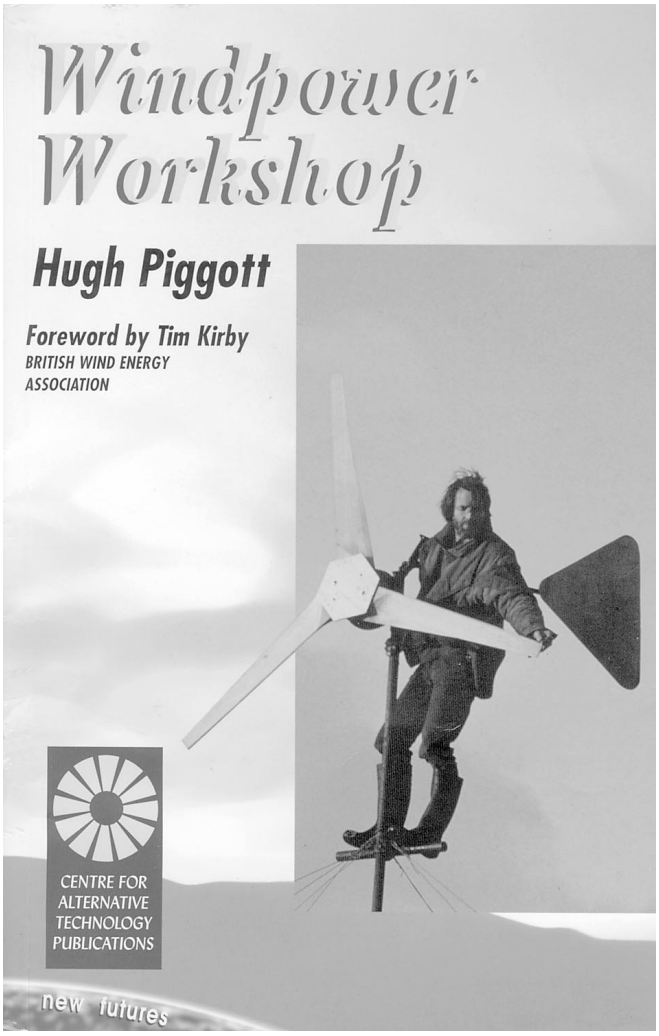
Solar Cookbooks

Solar Cooking Naturally, Sunlight Works, POB 3386, Sedona, AZ 86340 • 602-282-1344

Cooking with the Sun, Morning Sun Press, 1240 Quanolt Rd, Lafayette, CA 94549 • 510-932-1383 • FAX 510-934-8277

Favorite Recipes From Solar Cooks, SMUD, 6201 "S" St, Box 15830, Sacramento, CA 95852

Morning Hill Cookbook, HC84, Izee Route, Canyon City, OR 97820 All the solar recipes in this wonderful natural foods cookbook are marked with a little sun. The author, Jennifer Stein-Barker, will soon be releasing an all solar cookbook. I highly recommend any of Jennifer's books. This woman really knows how to cook.



Windpower Workshop

Written by Hugh Piggott
Reviewed by Paul Gipe

Finally, something to supplant Michael Hackleman's aging classic *Wind and Windspinners*. *Windpower Workshop* by Hugh Piggott is a welcome addition to any small wind turbine library and is a must if you want to, as the British say, "Do It Yourself."

Windpower Workshop is a 1997 release in the Centre for Alternative Technology's series on small wind turbines. For more than twenty years CAT has been demonstrating the use of alternative technology. *Windpower Workshop* grew out of Hugh's lectures at CAT on how to build low-cost wind machines.

The United Kingdom's foremost authority on small wind turbines, Hugh is also the author of CAT's *It's a Breeze: A Guide to Choosing Windpower*, as well as *Scrapyard Windpower Realities*. The latter, now out of print, was a good hands-on guide to building a small wind turbine from a permanent-magnet generator, a brake drum, and other salvaged auto parts. (Plans for the brake-drum windmill are still available directly from Hugh.)

Hugh's book is a distillation of more than two decades of mostly off-grid wind power experience on a remote windswept peninsula in far northwestern Scotland. Many of the homes, schools, and workshops in the vicinity use wind power and Hugh has either built the turbines himself or services them.

I immediately liked Hugh's organization of *Windpower Workshop*. He has the guts to put a discussion of safety right up front where it counts. Hugh relates a literally hair-raising tale of an encounter between North American wind guru Mick Sagrillo and a whirring Jacobs generator.

Yanks will find interesting Hugh's description of the small multi-blade micro turbines that British companies have developed. Their durability and low cost could offer an alternative to less robust domestic designs. In Europe, they have been used extensively in yachting and also power remote telephones and electric fences.

Since I am in the process of erecting my own mini-wind turbine, I found Chapter 8 on towers especially useful, notably Hugh's description of the TirFor hand-operated grip-hoist puller or winch. There are other brands on the market, but they all pull a steel cable through the body of the winch, rather than wrapping the cable around a spool.

Hugh packs his TirFor with him to service wind turbines at remote Youth Hostels and railway stations in Scotland. Anything that Hugh can't carry gets left behind. If you have to buy any tool for your off-the-grid wind system, Hugh recommends buying the grip-hoist winch.

For North Americans, there's real value in reading about small wind turbines written by a European. We are sometimes too insular and forget that there's a big world out there. Europeans have different experiences, different wind turbines, and different ways of doing things from which we can learn.

Hugh writes in the simple no-nonsense manner that I prefer. His illustrations are straightforward and he has introduced some original graphics. I found his depiction of losses in a wind system both unique and informative.

Windpower Workshop includes a comprehensive list of British consultants, dealers, and manufacturers of small wind turbines, a seven-page glossary, and a useful list of equations. What sets these formulas apart is their presentation. Hugh provides them in a helpful format suitable for keying into a spreadsheet so the readers can make their own calculations. Do-It-Yourselfers will greatly appreciate that gesture.

Windpower Workshop, says Hugh, was "written for those who want to build their own windmill and for those who dream." It's books like this that keeps the dream alive.

Access
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Windpower Workshop, by Hugh Piggott, Centre for Alternative Technology Publications, May 1997, ISBN 1-898049-13-0, 158 pages, 5-1/2 by 8-1/2 inches paperback, UK£10.95, including post and packing.

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HAPPENINGS

ARGENTINA
XII World Hydrogen Energy Conference, June 21-26, 1998, Buenos Aires, Argentina. For more information contact: Secretaria General: Congresos Internacionales S.A., Moreno 584-Piso 9-(1091) Buenos Aires, Argentina • Tel: 54-1-342-3216/3283/3408 • Fax 54-1-331-0223/334-3811 • e-mail: congine@mbox.servicenet.com.ar

AUSTRALIA
The World Solar Challenge is now a biennial event and will run October 18–27, 1998. It is the premier solar car race in the world and contributes vital research and development towards the quest for sustainable future transportation. New: Entry Competition open to school and tertiary entrants. Free entry to the first school and tertiary teams to register. Contact: Ray Wieland, Event Manager, level 7 178 N Terrace, Adelaide 5000, South Australia • +61 8 8303 2021 • E-mail: wsc@saugov.sa.gov.au • Web: www.wsc.org.au

BELGIUM
October 1–3, 1998: 15th International Electric Vehicle Symposium and Electric Vehicle Expo, Brussels. Contact: EPE Assoc., c/o SRBE-KBVE, c/o VUB, Pleinlaan 2, B-1050 Brussels, Belgium • telephone 32-2-629-28-19 • Fax 32-2-629-36-20 • bsneyers@vub.ac.be • www.avere.org/evs15

CHINA
International Conference & Exhibition on Energy & Energy Conservation, Oct. 20-22, 1998, Shanghai Mart, Shanghai. Contact: ICEEEC, Rm 1322 Bldg. 3, 1486 Nanjing Rd. (W), Shanghai 200040, P.R. China • Fax: 86-21-62049481 • wjyao@online.sh.cn.

Renewable Energy & Energy Efficiency Asia-Pacific '98 (REAP'98) Conference and Exhibition, Shanghai, China, October 14–16, 1998. Contact: Alternative Development Asia Limited, 1406 Leader Commercial Building, 54-56 Hillwood Road, TST, Kowloon, Hong Kong • +852-2574-9133 • Fax: +852-2574-1997 • E-Mail: office@adal.com • Web: www.adal.com

CANADA
The "Alberta Sustainable House" is open for public viewing on the 3rd & 4th Saturday of every month (except holiday weekends) from 1:00-4:00 PM free of charge. The project emphasizes cold-climate features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, grey water heat exchangers, LED and electro-luminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary, Alberta T3L 1V9, Canada • 403-239-1882 • Fax: 403-547-2671 • http://www.ucalgary.ca/~jdo/ecotecture.htm e-mail: <jdo@acs.ucalgary.ca>

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada • 902-892-9578.

Electric Vehicle Society of Canada, Toronto Chapter—whose purpose is to promote EVs in order to reduce the terrible environmental impacts of conventional automobiles (and have some fun at the same time!) are a group of enthusiasts, inventors, Sunday mechanics and environmentalists from every walk of life who share the belief that EVs are a viable alternative. Meetings on the 3rd Thursday of each month, September through June. New Members welcome! Contact: Howard Hutt, 21 Barritt Rd, Scarborough, Ontario, M1R 3S5 Canada • Phone/Fax: 416-755-4324

TURKEY
International Istanbul Energy Technology Exhibition, Oct. 22-25, 1998, CNR World Trade Center-Istanbul. Trade show, professional contacts, and technical meetings toward informing industrial and government offices about new energy technologies. Contact: Center for New Relations, World Trade Center, Atatürk Havalimani Darsisi, Yesilkoy 34830 Istanbul • 90-212-663-08-81 • Fax: 90-212-663-09-73-75 • E-Mail: ifnrg@ibm.net

NATIONAL
The PRSEA Chapter of ASES is sponsoring the 4th annual National contest for high school students. To enter, students design a photovoltaic powered device. Entries are judged by originality, presentation, and understanding. First prize is $500 with additional prizes for other winners, teachers, and schools that sponsor entries. More information is available at solstice.crest.org/renewables/prsea/.

National Summary Reports on State Financial and Regulatory Incentives for Renewable Energy: These two reports provide the most current info on state and federal tax, grant and loan programs that target renewable energy. Also, check out the online Database of State Incentives for Renewable Energy on their web site. To order reports, contact: North Carolina Solar Center, Box 7401 NCSU, Raleigh, NC 27695 • 919-515-3480 • Fax: 919-515-5778 • Web: www.ncsc.ncsu.edu/dsire.htm

Sandia's new WWW address is www.sandia.gov/pv and they have added new material and organized it to make material easier to find. It includes "Stand-Alone Photovoltaic Systems: A Handbook of Recommended Design Practices," "Working Safely with PV," and balance-of-system technical briefs which provide information about battery and inverter testing.

Solar Energy & Systems is a college credit course offered by Mojave Community College. It covers fundamentals of RE for the home owner or small village. Taught on the Internet using the latest technology, it contains weekly assignments for students to review various text books, videos, WWW pages, a weekly chat room, and email questions and answers from students. Tuition is $100 plus $10 registration. Call 800-678-3992 or e-mail Elizabeth Cawley: lizcaw@et.mohave.cc.az.us • Prof Charlie Collins: chacol@hal.mccnic.mohave.az.us

DOE Online Energy Info Resources contains information on energy efficiency and renewable energy technologies. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) BBS Online Service offers users free access to text files, share and freeware programs and utilities, and a free publication ordering system. Accessible via the Web: erecbbs.nciinc.com • Modem: 800-273-2955. The Energy Efficiency and Renewable Energy Network (EREN) is accessible on the Web at www.eren.doe.gov and provides links to hundreds of government and private internet sites. EREN also offers an "Ask an Energy Expert" online form that allows users to E-mail their questions directly to specialists at EREC. For more information • 800-363-3732.

American Hydrogen Association national headquarters: 1739 W 7th Ave, Mesa, AZ 85202-1906 • 602-827-7915 • Fax 602-967-6601 • Fax 602-967-6601 • E-Mail: aha@getnet.com • "Prosperity Without Pollution" Web: www.clean-air.org

Energy Efficiency and Renewable Energy Clearinghouse (EREC) offers free info: 1998 Fuel Economy Guide (SD404), Insulation Basics (FS142), and Small Wind Energy Systems for the Homeowner (FS135), which reviews system requirements, site determination, and costs of residential wind turbines. Also: The New Earth-Sheltered Houses (FS120), Photovoltaics: Basic Design Principles and Components (FS231), Cooling Your Home Naturally (FS186), and Automatic and Programmable Thermostats (FS215). Contact EREC: PO Box 3048, Merrifield, VA 22116 • 800-363-3732 • E-Mail: energyinfo@delphi.com • TDD: 800-273-2957 • Modem: 800-273-2955 • Web: www.eren.doe.gov

American Wind Energy Association World Wide Web: www.igc.apc.org/awea. Obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

The Federal Trade Commission is offering free pamphlets on: Buying An Energy-Smart Appliance, the EnergyGuide to Major Home Appliances, and the EnergyGuide to Home Heating and Cooling. Write to: EnergyGuide, Federal Trade Commission, Room 130, 6th St and Pennsylvania Ave NW, Washington, DC 20580 • 202-326-2222 • TTY: 202-9326-2502. The full text of these and more than 160 other consumer and business publication are available • Web: www.ftc.gov

The Surface Solar Energy data set, derived from satellite observations and produced by the Atmospheric Sciences Division of NASA Langley Research Center is now available.

The data set contains site specific insolation values with monthly fluctuations, three hourly cloud fraction, and additional useful data. Text files, color plots and contour plots on a global scale are also available. Web: eosweb.larc.nasa.gov/DATDOCS/Surface_Solar_Energy.html

The Interstate Renewable Energy Council (IREC), in cooperation with the SEIA and Sandia National Lab has a handbook to guide state and local government procurement officials and other users in the specification and purchase of renewable energy technologies. Information on biomass, photovoltaics, solar domestic water and pool heating, and small wind systems. Technology specs about equipment, photographs and vendor contact info. Contains information on simple methods for estimating the pollution benefits of RE systems. Send $15 ppd USA to Interstate Renewable Energy Council Distribution Center, c/o ASES, 2400 Central Ave Ste G-1, Boulder, CO 80301 (make checks to ASES).

SOLAR 98: Renewable Energy for the Americas, June 13-18, 1998, Albuquerque, New Mexico. The conference includes all renewable energy technologies and professions. For more information contact: American Solar Energy Society, 2400 Central Ave. G-1, Boulder, CO 80301: phone • 303-443-3130, Fax • 303-443-3212 • e-mail: ases@ases.org; web-site: http://www/ases.org/solar

NORTHEAST US

ALABAMA

The Self-reliance Institute of Northeast Alabama is seeking others in the southeast interested in alternative energy, earth sheltered construction, and other self-reliant topics. Contact SINA, Route 2 Box 185A1, Centre, AL 35960 • E-Mail: cevans@peop.tdsnet.com.

ARIZONA

The State of Arizona is offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the AZ Department of Commerce must be on each job site. For info contact ARI SEIA • 602-258-3422.

The Southwest Energy Fair, September 19-20, 1998, Flagstaff Arizona will offer technical, general public, and children's workshops as well as project, debate, and essay contests for students. An electric car race and EPCOT center solar exhibit. Commercial booths will be available and we are looking for individuals and companies to give demonstrations, hold workshops, or have ideas to contribute. On-site camping will be available as well as numerous free recreational opportunities for vendors. For more information call the Greater Flagstaff Economic Council at 1-800-595-7698 • e-mail: gfec@primnet.com

1998 North American Electric Vehicle & Infrastructure Conference and Exposition, December 3–4, 1998, Phoenix, AZ. For more information contact: EVAA, 601 California St Ste 502, San Francisco, CA 94108 • 415-249-2690 • Fax 415-249-2699 • ev@evaa.org • http://www.evaa.org

CALIFORNIA

Campus Center for Appropriate Technology, Humboldt State University, Arcata, CA has ongoing workshops and presentations on a variety of alternative, renewable, and sustainable living subjects. Contact: CCAT, HSU, Arcata, CA 95521 • 707-826-3551 • E-Mail: ccat@axe.humboldt.edu • Web: www.humboldt.edu/~ccat

Tehachapi Wind Fair, A celebration of renewable energy choices, is scheduled for July 18th & 19th, 1998 in the Tehachapi City Park. For additional information or questions you can call the Kern Wind Energy Association at 805-822-7956.

Home = Education Conference, HomeSchool Assoc. of CA conference, Aug. 21-23, 1998, Radison Hotel in Sacramento, CA. Contact: PO Box 2442, Atascadero, CA 93423 • 888-HSC-4440 • E-Mail: conference@hsc.org • Web: www.HSC.org

Siemens Solar Industries offers two levels of PV training: Basic PV Technology Self-Study Course (continuously available), and the Comprehensive Photovoltaic System Design Seminar (call for seminar dates). Instructor Mark Mrohs, Manager of Training for Siemens Solar. The Self Study program includes our 500-page Training Manual and 9 hours of video lessons and applications, with exercises and examples throughout. The System Design Seminar is a 5-day intensive mixture of lecture, hands-on assembly, labs, and team system design problem solving. Completion of the Self Study program ($500 plus shipping and tax) is a prerequisite for the System Design Seminar ($1000). Contact: Siemens Solar Training Department, 805-388-6568 • Fax: 805-388-6395 • E-Mail: cvernon@solarpv.com • Web: www.solarpv.com

Rising Sun Energy Center presents ongoing Solar Energy Classes including electricity, water heating, cooking, and a kids' day. Contact for schedule and info: PO Box 2874, Santa Cruz, CA 95063 • 408-423-8749 • E-Mail: sunrise@cruzio.com • Web: www.cruzio.com/~solar

The National Marketplace for the Environment Conference and Trade Shop, A project of Eco Expo and the Environmental Education Foundation, May 6–8, 1998, Los Angeles Convention Center. For more information call • 800-334-3976

SolFest 98 Hopland, CA - Real Goods is proud to announce its solar-powered extravaganza to be held June 20-21 at the Real Goods Solar Living Center in Hopland, CA. The free, two-day festival celebrating renewable energy and sustainable living will offer speakers, educational workshops, live music, and demonstrations of "earth-friendly" products. Speakers include Jim Hightower of NPR fame, Winona La Duke, Native American activist, an Electric Vehicle Parade headed by Grand Marshall Ed Begley, Jr, Ben Cohen of Ben and Jerry's Homemade Ice Cream, Peter Warshall, editor of the Whole Earth Magazine, and Alan Weisman, LA Times writer and author of the new book Gaviotas. Music by Ancient Future Celtic Raga Duet a blend of Indian music with Celtic overtones and Scott Huckabay and Daniel Paul will create "a live stage ritual" with pulsing acoustic guitar and vibrant tabla rhythms. Free workshops on solar power, straw bale construction, industrial hemp, social investing, and much more will take place throughout both days. Special guests include Josh and Kaia Tickell, demonstrating the infamous Veggie Van, powered by used restaurant frying oil, and "Garbage Man," a pointed environmental comic relief for all ages. For more info: Deb Robertson, Public Relations, Real Goods, 555 Leslie St., Ukiah, CA 95482 • 707-468-9292 X2221 • deb@realgoods.com

COLORADO

Solar Energy International (SEI) offers hands-on workshops on the practical use of solar, wind, and water power. The Renewable Energy Education Program features one and two week sessions: PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Solar Home Design, Environmental Building Technologies, and Straw Bale Construction. Experienced instructors and industry representatives. For owner-builders, industry technicians, business owners, career seekers, and international development workers. The workshops may be taken individually or as a comprehensive program. $500 per week. SEI is a non-profit organization dedicated to the practical use of RE. SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 • E-Mail: sei@solarenergy.org • Web: www.solarenergy.org

National Wind Technology Center is operated by the NREL, just outside of Golden, CO. The facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance 303-384-6900 • Fax: 303-384-6901.

SEI is offering a special workshop on how to establish and operate a successful solar business. This two day workshop will be taught by Richard and Karen Perez, editors/publishers of Home Power Magazine. The workshop is for those serious about being renewable energy professionals. Topics include: career choices, RE industry perspective, marketing strategies, product sales & services, optimizing computer systems & legal & tax issues.The cost for both days is $200. Advanced registration required. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 • E-Mail: sei@solarenergy.org • Web: www.solarenergy.org

SunDependence Day—Solar Potluck and Green Living Festival will be happening in Carbondale, CO on the 4th of July. Parade, children's activities, displays and demonstrations. Homebrew Competition, Town potluck, music and fireworks! Please

contact Ed Eaton at Solar Energy International 970-963-8855 • sei@solarenergy.org

FLORIDA
The Changing World Of Industrial & Recreation Electric Vehicles August 20–21, 1998. The Conference will focus on non-road vehicles and technologies at the Hilton at Walt Disney World Village, Orlando, FL. Contact: EPRI, 3412 Hillview, Ave, PO Box 10412, Palo Alto, CA 94303, • 415-855-2000 • 222.epri.com

IOWA
Iowa Renewable Energy Association board meetings are held the second Saturday of every month at 9:00 am, at Cooper's Mill Restaurant (Village Inn Motel) in Cedar Rapids. Everyone is welcome. Time and place of meeting may change so call I-Renew for updated information. Contact: I-Renew, PO Box 2132, Iowa City, IA 52244 • 319-338-3200 • Fax: 319-351-2338 • E-Mail: irenew@igc.apc.org

The Iowa Renewable Energy Association is sponsoring workshops this spring on Straw bale houses, Domestic Hot water installations, and DC Photovoltaic systems at Prairiewoods Nature Center near Cedar Rapids, Iowa starting in June. For more info contact IRENEW or Tom Snyder, 611 Second St. SE, Dyersville, IA, 52040, tsnyder@mwci.net or Prairiewoods, 120 E. Boyson Road, Hiawatha, IA 52233 • 319-395-6700.

KENTUCKY
Appalachia - Science in the Public Interest has ongoing projects and demonstrations in gardening, solar, sustainable forestry, and others. Contact: ASPI, 50 Lair St., Mt. Vernon, KY 40456 • 606-256-0077 • E-Mail: aspi@kih.net • Web: www.kih.net/aspi

MAINE
American Solar Energy Society annual conference, Solar 1999, June 12-17, Portland, ME. Contact: NESEA, 50 Miles St, Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053

MARYLAND
Creative Alternatives will hold its annual Creative Alternatives Expo at the silver Spring Armory, 925 Wayne Ave, Silver Spring, MD on June 20, 1998 at 10 am to 7 pm. Numerous booths, demos, and presentations on: alternative energy technology, agriculture, health and education. Plan to be part of this mind-expanding & eye opening event. For further info contact, Expo Director, Melvin Saunders, 1463 Berger St, Odenton, MD 2113 • 410-672-2285 or 310-912-1976

MASSACHUSETTS
The Northeast Sustainable Energy Association (NESEA) and the Timber Framers Guild of North America are presenting the 14th Annual Quality Building Conference, the 14th Annual Timber Framers Guild of North America's Eastern Conference, RENEW '98 and a week-end Solar-Powered Music & Educational Festival at Westfield State College in Westfield, MA, July 23–26, 1998. For further information please contact NESEA, 50 Miles St, Greenfield, MA 01301 • 413-774-6051 • fax 413-774-6053 • e-mail: nesea@nesea.org • web site: www.nesea.org

Greenfield Energy Park needs your help building its efforts preserving Greenfield's historic past, using today's energy and ideas, and creating a healthy sustainable future. Contact: Greenfield Energy Park, NESEA, 50 Miles St, Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053

MICHIGAN
EnV'98, Environmental Vehicles and alternative fuels conference and exposition, June 15-17, 1998 Ypsilanti, MI. Contact: 29355 Northwestern Hwy #200, Southfield, MI 48034 • Web: www.esd.org

Tillers International lists classes in draft animal power, small scale farming, blacksmithing and woodworking. For a class catalog contact: Tillers International, 5239 S. 24th St., Kalamazoo, MI 49002 • 616-344-3233 • Fax: 616-344-3238 • E-Mail: TillersInt@aol.com • Web: www.wmich.edu/tillers

Cob Workshop Intensive as part of the Michigan Women's Festival, August 11–16. Contact: PO Box 22 Walhalla, MI 49458 • 616-757-4766

MONTANA
Sage Mountain Center offers its Lifeskills Workshops for 1998. One day, comprehensive classes include: inexpensive earth-friendly home building, straw bale construction, making log furniture, cordwood construction, natural and nontoxic interiors, and more. $45 includes lunch and literature. Also, a free tour of SMC is set for April 25 in commemoration of Earth Day. For details call or write: SMC, 79 Sage Mountain Trail, Whitehall, MT • 406-494-9875

NEW HAMPSHIRE
Nuclear Free New England Music Festival. Forces of Nature, a non-profit grassroots organization, is sponsoring the Festival on June 27, 1998 at the Seabrook Race Track in Seabrook, NH. Following the festival, on June 27–28, there will be a grand march and non-violent direct action at the Seabrook Nuclear Power Station. Non-violence training will be offered for those interested in direct action. Speakers include Native American activist John Trudell and NIRS director, Michael Mariotte. For more information visit • http://www.tiac.net/users/fonature or e-mail • fonature@tiac.net

NEW MEXICO
Solar 98: Renewable Energy for the Americas, June 13-18, 1998, Albuquerque, NM. Featuring the ASES, ASME, and AIA conferences for RE. Contact: ASES, 2400 Central Ave., #G-1, Boulder, CO 80301 • 303-443-3130 • Fax: 303-443-3212 • E-Mail: ases@ases.org • Web: www.ases.org/solar

OREGON
APROVECHO RESEARCH CENTER is a non-profit educational institute on forty acres nestled in the forest of Oregon. Internship programs March 1, June 1, and September 1. Also, a six week winter internship in Baja, Mexico which focuses on studying and researching appropriate technology applications, learning Spanish, teaching in a grade school, and working in fruit orchards and gardens. Contact: Internship Coordinator, Aprovecho Research Center, 80574 Hazelton Rd., Cottage Grove, OR 97424 • 541-942-8198.

The Lane Community College Energy Management Program is offering a Photovoltaics Design Course Spring Term 1998. Course content includes PV electricity basics, modules, batteries, controllers, inverters, lighting, appliances and installation guidelines. The course will include a tour of local PV installations and will culminate in a residential design project. Several guest speakers from the PV field will participate. For further information please contact Roger Ebbage, CEM, Coordinator of the Energy Management Program at LCC, 541-747-4501 ext 2451 or 800-769-9687 • eggaber@lanecc.edu • http://lanecc.edu:180/webpages/lcc/science/home.htm

TEXAS
SEASUN, El Paso Solar Energy Association • Web: www.epsea.org

VERMONT
Free PV Workshops for beginners and experienced off-gridders. 9 am to 3 pm the first Saturday of most months. Participant interest determines the topics: site selection, PV modules, batteries, charge controllers, inverters, lighting (ac & DC), balance of system components, system monitoring and maintenance, water topics, snow topics, ponds, living in cold climates, living with our woods, heating with wood, and root cellars. Visit a beautiful part of Vermont and meet other people living with renewable power or considering it. This is a freebie so bring your own lunch and coffee. Contact: David Palumbo, Independent Power and Light, RR1 Box 3054, Hyde Park, VT 05655 • Voice/Fax: 802-888-7194 • E-Mail: indeppower@aol.com

WASHINGTON
GreenFire Institute is offering workshops and information on straw bale construction. Contact: GreenFire, 1509 Queen Anne Ave #606, Seattle, WA 98109 • 206-284-7470 • Fax: 206-284-2816 • Web: www.balewolf.com • E-Mail: wilbur@balewolf.com

WE-Design presents its 1998 series of sustainable living workshops in Seattle, WA. Sustainable Living Apprenticeship, July 13 - Aug. 9 in Orcas Island, $1500. Permaculture and Natural Building Design Course, Dates TBA in Oakville, $550. Contact: WE-Design, PO Box 45472, Seattle, WA 98145 • 206-323-6567

Women's Natural Building Symposium, June 15-22, Open Symposium, July 1-7. Near Seattle. Contact: Groundworks, PO Box 381, Murphy, OR 97533 • 541-471-3470 • www.cpros.com/~sequoia

The First Open Natural Buildings Symposium, July 1–7, 1998 near Seattle, WA. Come Co-create magical natural buildings out of earth, straw, wood, and stone with homemade plasters, paints and floors. For more information contact: Groundworks, PO Box 381, Murphy, OR 97533 • 541-471-3470 • www.cpros.com/~sequoia

The River Farm Community Land Trust in NW Washington is hosting its second annual Renewable Energy Fair and Solstice Celebration, June 20th & 21st. This year features a "coopetition", with prizes in various categories of appropriate technology and environmentally friendly energy systems. The mission of the Fair is to display, promote and foster learning of alternative methods of generating power and doing work, in an atmosphere of playful celebration. This Fair will also feature a multitude of regional musicians on a solar-powered stage,a kid's carnival, and organic food. For more information on presenting and attending, contact the River Farm Renewable Energy Fair, 3231 Hillside RD, Deming, WA 98244. (306) 592-2716 ext. 4

WASHINGTON, DC

Excellence in Building Conference and Expo, Oct. 28-31, 1998, Sheraton Washington Hotel. Building science, construction practices, marketing, utility, and gov't. programs. Contact: EEBA, 2950 Metro Dr. #108, Minneapolis, MN 55425 • 612-851-9940 • Fax: 612-851-9507 • Web: www.eeba.org

Utility PV Experience, Conference and Exhibition will share experience of energy service providers engaged in introducing solar electricity to customers. Contact: Erin O'Donnell, Utility Photovoltaic Group, 1800 M Street, NW, Suite 300, Washington, DC 20036 • 202-857-0898 • Fax: 202-223-5537 • E-Mail: eodonnell@ttcorp.com

WISCONSIN

Midwest Renewable Energy Association Workshops. Call MREA for cost, locations, instructors and further workshop descriptions. See our ad in this issue. Membership and participation in the MREA are open and welcome to all. Significant others may attend for 1/2 price. Contact: MREA, PO Box 249, Amherst, WI 54406 • 715-824-5166 • Fax: 715-824-5399

Bioenergy '98, 8th Biennial Conference, Oct. 4-8, 1998, Madison. Contact: Great Lakes REgional Biomass Energy Program, 35 East Wacker Dr. #1850, Chicago, IL 60601 • 312-407-0177 • Fax: 312-407-0038 • Web: www.cglg.org/bioenergy98

The University of Wisconsin-Madison, will offer a course on Residential Energy Auditing July 13—17, 1998. Learn about what procedures to use, how much time to budget, what experience is necessary, what instruments are useful, and how to calculate economic benefits. The course includes a training manual and other textbooks. For more info: Katie Peterson, Department of Engineering Professional Development, University of Wisconsin-Madison, 423 N Lake St, Madison, WI 53706 • 800-462-0876 • Fax 608-263-3160 • custerv@epd.engr.wisc.edu • http://epdwww.engr.wisc.edu/

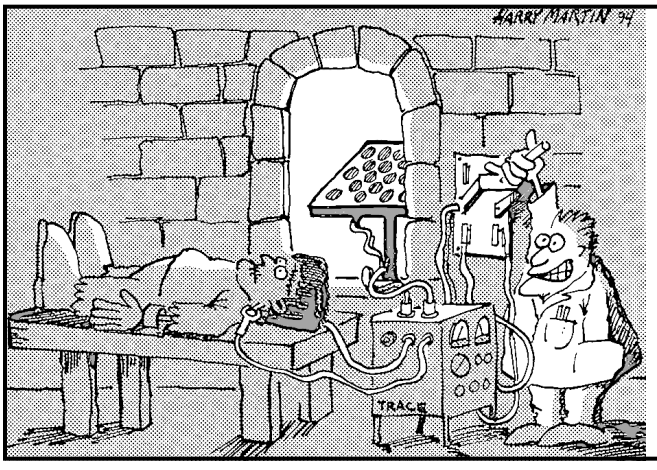
the Wizard speaks...

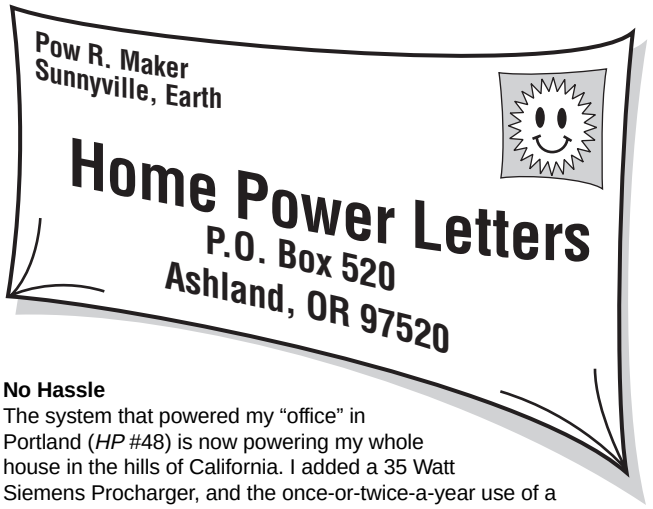
The Mind

Since the first stirrings of the philosophical impulse, a debate has existed concerning the nature of the mind. On one side are those who believe that the mind consists only of the electrical impulses of the body and the brain. On the other are those who believe that the mind is a transpersonal and supraphysical phenomenon. There is, however, an intermediate viewpoint.

This third viewpoint considers the mind to be a self-regenerative, standing wave pattern in the zero point field, containing both vector and scalar aspects. The processes of the body and brain support this pattern and are influenced by it. However, the pattern has the potential to exist and sustain itself without the presence of the original physical form. The more complex and internally interconnected the pattern is, the greater its capability is for self-regeneration and self-sustainability.

Upon the disintegration of the physical form, there are three possibilities for the pattern. It may disintegrate, leaving only the elemental patterns of atoms and molecules. It may become integrated into a larger and more complex pattern. Finally, it could become completely self-regenerative and self-sustaining, entering upon a new path of evolution.





No Hassle
The system that powered my "office" in Portland (*HP* #48) is now powering my whole house in the hills of California. I added a 35 Watt Siemens Procharger, and the once-or-twice-a-year use of a generator. Of course, my needs are small: three 20 Watt lights and a car stereo for tunes—but I can say that in over a year and a half in the hills, the solar system had been the one thing I have not had to hassle with. Moving water uphill is another story (a long and irritating one, so far) and the phone line doesn't work too well when it rains, but the PVs...ah...quiet and trouble free. Maybe next winter, I'll get a small windcharger together. I have an abundance of that resource as well. Keep up the fantastic work, Home Power is priceless. Mark Whitaker, Redway, California

Thanks for the flowers, Mark. One of the great features of PVs is their reliability. We have a module here that is over twenty years old and dozens which are over ten years old, and all are still making rated power. New PVs are now being sold with warranties of 25 years, and I have no doubt that they will produce rated power for at least *that long. What else in this life is as reliable, long-lasting, and maintenance free? Richard Perez*

What's It Worth
In response to James R. Udall's article in *HP* #64, I had flashbacks galore to the 1960s and 70s. As Art Linkletter said many times, "People are funny!"

Right after college graduation, I worked for Montgomery Ward selling stereos and TVs in Iowa City. Colored TV was just becoming the "in" thing, but no one wanted to be first. Comments such as "I'll buy when it comes down in price" (it didn't for many years), "who needs two TVs, for Pete's sake?" or, the best line, "I don't want to be the first on the block!". TVs, colored or not, are not, nor ever will be, cost effective! But my co-worker could sure sell them after he convinced them with all the emotional reasons. I'm not sure, but I think I read that today there is a TV set for every member of the family in the household. I haven't found the cost effectiveness in this example yet!

Second, during the 1973 "oil crisis", and later when gasoline prices doubled again, teaching people about the benefits of solar thermal (back then it was called active solar) was a lesson in futility. Those who bought and installed, as I did, learned from reading and doing. The rest of the public seemed to be guided by a "conspiracy theory" that the public bought into. Conspiracy is the word we used at the time to explain how the oil companies had convinced everyone that solar needed to be "cost effective!"

People in the late 1970s (at least here in Iowa) were driving big "boats" that got 10-12 miles per gallon. Right after the second "oil crisis" people were running to their new car dealer to spend thousands of dollars on a new car to improve their gas millage. In every case analyzed, the car wore out before recovering the cost of the vehicle! Even without the government tax credits at the time (under Jimmy Carter), active solar "pay back" in seven years was (and has been proven) to be easily attainable. These new car buyers would shake their heads in disbelief on the pay back of active solar as they sped away in their new car!

As a parting thought, it is scary to see the whole cycle repeating itself again.

Fuel efficiency is not important to many new car buyers, and the argument of "pay back" is still in the way of renewables. Maybe the oil companies periodically renew the payback idea just to keep the public up to date and informed! Tom Snyder, Dyersville, Iowa

Yep, Tom, Randy Udall certainly did a bang up job of debunking the payback myth in his cover story in HP *#64. As long as the utility-produced energy is heavily subsidized by our taxes, it is very difficult to say what it actually costs. As long as the utilities continue to pollute, it is difficult to put a real price tag on their energy. All of the utilities' hidden costs makes it easy for them to claim that RE is more expensive. My opinion is that when all of the concealed costs are revealed and totaled, RE is now, and has been for quite a while, a cheaper way to make electricity. Richard Perez*

Codes and Wrenches
I like the debate between code authorities and "wrenches." As a building contractor, I'm engaged in the same type of arguments with my building inspectors.

This summer I hope to (finally) start setting up a solar electric system on a house I've been building. I'm somewhat apprehensive regarding local electrical inspectors. Any articles on the subject of what to look out for, what are critical points, and new changes, etc. are helpful. Thanks for a fine magazine. Ande Nazar, Shutesbury, Massachusetts

Hello, Ande. If you want to come up to speed on the National Electric Code and RE systems, your best (if not only) resources are the Code Corner and Wrench Realities articles in Home Power*. Here's some obvious items to look out for: Use UL listed equipment—most inspectors will pass UL listed gear without problems. Follow conventional wiring techniques using NEC accepted conductors for the job. It's not difficult, it's just a matter of following the rules. If you have doubts, then consult with a local RE dealer or licensed electrician—they know how to do code compliant installations. Richard Perez*

A Small Wrench
Guess I'm a small wrench. I started in May 1984 with one battery and two tail light bulbs. I have built and/or installed my present system without any trouble. It is my feeling that Mr. Wiles is dead wrong on many points; to name a few: grounding, diodes, fuses, conduit, wire rating, etc. I have been a reader of *Home Power* since issue #1. In fact, I have all issues at hand. Re-reading them gives me the feeling that Mr. Wiles would like to hold up home-made power however possible. W E Stephens, Sanger, Texas

Hey, W.E., I'd like to speak out in John Wiles defense. John is a first-class, solar energy advocate. He goes home to PV power at night just like you and I both do. He has the very difficult job of standing between such diverse entities as the NEC and the Wrenches. His major motive is safer RE systems, and in this he has been very effective. Let's not shoot the messenger because we might not agree with the message... Richard Perez

Web Access
I agree when you say that you put the mag on your site to "spread the work." I disagree that new subscribers should have full access to the info for free. The automotive industry has a mag ,"Collision Insight", that has a free site with password protected areas for subscribers to the mag. You have a fine publication with paying subscribers like myself. Why give it away for free? I love my new Solar 2 CD-ROM. I travel and my CD laptop *HP* has oh-so-many miles on it. Best to you and the *HP* crew. Ray Yankowski, San Diego, California

Hello, Ray. The reason we give Home Power *away for free on the Internet is to spread the word about using renewable energy. Too few people know what can now be accomplished using RE. I'd give the*

magazine away for free in the paper version if that were possible. On the Internet, we can spread this info quickly and inexpensively. We are going to keep the downloading of the current issue free. I, too, use the Solar 2 CD-ROM all the time. It's far easier and faster to find specific info on the CD than it is in the printed version. We appreciate your support when you subscribe, and we appreciate your attention when you download the free issue. As long as enough folks keep subscribing, we'll keep the electronic version free for the downloading. Richard Perez

Basic Needs

I do love your magazine, and it's wonderful how it has grown in size, quality, and advertising (I like the ads, too—they're targeted at me). I've been enjoying it ever since I used to pick it up for free at a little solar retailer near Espanola, NM where I bought my first solar rig. That stuff is still powering all of our basic needs in our newly transplanted location in the Mother Lode of Central California. Unfortunately, very little sun falls anywhere near our house because of the huge trees around us. That's a blessing in the summer when our house is always many degrees cooler than outside, but it has frustrated this solar die-hard to no end. Our current solution is to have the batteries in a custom-built wagon which we pull down to the panels during the day and back up to the house at night. When I get rich, I'm going to have a "power house" in the pasture where the sun shines. I'll put an inverter there so that I can ship the power up to the house at 120 vac. Maybe we can stop pulling the wagon some day before we can't do it any more.

We especially appreciate that you cover a full range of solar possibilities including the micro-system users like myself. There is plenty to be said for reducing your electric needs to what you are able to provide. I was in a quandary about answering your survey because in terms of hours of electric use we are mostly solar (very low wattage), but in terms of Watts of electric use the generator wins. This is even though we run it very little because it does all of our heavy tasks like water pumping (to a gravity system). I don't know if you could make your survey easier, but I felt like I wasn't quite telling the truth either way. D F, Twain Harte, California

Hello, DF. You are right on target with the "power shed" concept. Many folks are going this way with great success. First off, it places the modules in the best location. Second, it takes the RE gear (especially batteries) out of the house. This makes the system safer, easier to have inspected and insured. Third, it is the most efficient way to use the equipment. Power sheds are real winners!

We scratched our heads long and hard to generate the sub form we now use. It's not ideal, but it seems to work most of the time. We only ask you these questions so that we can make a better magazine for you. We appreciate and pay attention to each and every survey which contains any data. Thanks for filling yours out! Richard Perez

Gravity Syphon DHW

John Whitehead's innovative design for the gravity syphon water heater should be applauded.

However, as a licensed plumber, there are a few very important things I should point out. I'm sure this water heater makes hot water just fine, but it could easily kill you. First, plastic fittings and pipe are being used where pressurized air may exist. The manufacturers in the USA specifically stipulate that this is not to be done. The "rated" pressure is for hydrostatic pressure, not air pressure. This is because PVC and CPVC fracture like glass. The flying pieces, under the pressures suggested in this article, could certainly be deadly.

Second, while there is in fact a T&P relief valve on the author's air-add-tank, there is no mention of it in the article. Also, the author suggests using a tank in its inverted position, which is an act which could render its T&P valve useless. Without a T&P valve, the flow rate could be regulated down in such a way that the water temperature could get as high as 300°F. In turn, this could cause an explosion big enough to literally make toothpicks out of a standard wood frame house! (Not to mention that 300°F water exceeds temperature ratings for any plastic pipe for potable water.)

Third, the top tank resting on its side will eventually cause the anode rod to be high and dry. Steel rusts where there is an interface between water and air. These tanks will rust much faster than tanks completely filled with water.

Fourth, but not least important: water heater tanks are rated for 300 psi burst, 150 psi working pressure. Again, this is hydrostatic pressure, not air or steam pressure! I once tested an old water heater for leaks with air pressure. The gauge reading was 15 psi when the tank exploded. I was fortunate to avoid serious injury! 15 psi is enough air pressure to take nicely formed steel in the shape of a tank and open it up so it looks like a giant clam shell that has been split open.

I urge you to print a warning/retraction before someone blows up their house and kills their kids. Bernard Edl, Seattle, Washington

Victorian View

I really enjoy your publication, although my biggest complaint is that so many of your advertisers and some of the article writers are reluctant to divulge actual costs. They seem to view the subject of money the way that Victorians viewed sex: "Yes my dear, we know people are engaging in *that* kind of activity, but polite people Do Not discuss it."

I find it quite galling that some advertisers expect me to call them long distance or write a letter just to find out the price of their goods. Frequently, the number I am quoted appears to be an attempt to finance a condo in Aspen, Colorado with the proceeds from a single sale.

By now, I expect some of the most flagrant violators of common courtesy are probably raising their voices in a chorus of "but other people are doing it". W J Stemke, Round Up, Montana

High Marks

Your mailing service gets high marks from me. Recently, they made an error concerning my subscription and promised to make up for it. They did. Some mailing services are fairly disconnected from their employers both in practices and in ideology. St Croix Press left me feeling as though I'd been dealing with an extension of the Home Power Crew. Many thanks to them.

Re: Advertisers and Pricing: I vote for the continuation of published prices by advertisers if they so choose. I do not know the name of the businesses opposing this practice, but my first reaction to the complaint is one of suspicion: Is it their intention to create a clear path for gouging the public?

Let's keep clean energy clean throughout—including the business side of it. Keep prices fair and out in the open. This country has enough reason already to boldly exclaim, "caveat emptor" (Let the buyer beware). We can enter the next millennium with a new attitude: clean energy/clean business. Jim Wirth, Carlsbad, California

On the Brink

When your advertisers don't state prices, it tells me their prices are not competitive.

You think, and I agree, that RE is on the brink of major growth in acceptance and practicality. We, the subscribers, want you to support this by evolving from your passive stance by advocating for your readers, holding the manufacturers and suppliers to high standards of performance, reliability and cost effectiveness, by comparing products, and fostering constructive competition. Robert Love, Salt Lake City, Utah

Well, Robert, we've actually been doing as you suggest since issue number one. We have refused advertising from companies we know do not live up to their warranties, advertising claims, and those who have demonstrated dishonest business practices. We don't make a big deal out of this, we just do it. Richard Perez

No Government Control
Keep as much detail as possible: no "Popular Science" answers that don't show wire polarity or pipes, etc. Please stay away from government assistance schemes as they invariably result in government control of this field. (This is not to be considered a put down on government "watch dog" operations which I consider a legitimate exercise of governmental power.) Never pander to the lowest common denominator. Encourage everyone to climb the ladders of knowledge (as you presently do). Joseph Hutchinson, Wellington, Colorado

Thanks for the encouragement, Joseph! Almost all of the home power systems out there were established with no help from governments, utilities, energy extensions, and other groups. Small scale RE has always be a fertile field for do-it-yourselfers. As RE technologies mature and become more widespread, this is changing. More and more folks are having RE installed by dealers. Everyone still needs to know how the system works or they will be unable to either effectively operate or maintain it. Knowledge is indeed power... Richard Perez

TTW?
You have an excellent publication—Keep up the good work. What happened to Things That Work? I would also like to hear you comment more on "Power Pulse" battery maintenance systems—*HP* #63, pg 48. That technology didn't work very well when it first came out. What have they done to overcome the earlier problems? I am interested in this but am skeptical. I would also like to know what software you are using to produce your schematics. Paul Hembise, Scottsdale, Arizona

Due to space and time problems, I have fallen behind in our Things that Work! testing program. I'm doing my best to catch up. Regarding the Power Pulse, we are unable to make a complete and scientific test of the product. Such a test would require dozens of equally sulfated batteries, a control group, and years of time. We have received dozens of letters from Power Pulse users, they think it works. I have one on our new lead-acid battery and I think it works. I have rejuvenated several very badly sulfated batteries using the Power Pulse. While we don't have what would be considered as scientific proof that it works, or data on how well it works, the hearsay info we get is that it does work. Early failures in the product had nothing to do with its function or design. The company making the early units (not the same company making them now) decided to move fabrication to the Pacific Rim in order to make more profit. The quality control on these Pacific Rim models was nonexistent and the failure rate was astronomical—it put the company out of business. The Power Pulse models being sold now are made in the USA. I consider them to be standard equipment for a lead-acid battery system—just like Hydrocaps and a battery Ampere-hour meter. Richard Perez

The software we use is a postscript Illustration program called Freehand, written by Macromedia. Really, we do it all from scratch. There is no library available for these components, except for the one we have created here at HP*. Ben Root*

More on TtW
"Things That Work!" items should really work, because your endorsement means a lot to buyers. Consider raising the level of sophistication of your tests. Two examples of "fluffy" tests are: 1) the Jade Mountain LED Light (the manufacturer no longer uses the LVD, it didn't work), and 2) the Morningstar charge controller (splashing a few drops of water near it doesn't show whether it's waterproof or not). You may want to run more long term field tests, rather than short term back room tests. Peter Banwell, The Asia Foundation, San Francisco, California

Things that Work! (TtW!) testing is far more rigorous than you think, Peter. We test all the products in working RE systems—often for a period of a year or more. In the last two years, we have tried to farm out some of this testing. We don't do this anymore because the test procedures used by others are not rigorous enough to suit me. Please be patient, real world testing takes time. We are re-doing our systems so that we will be better able to test a wide variety of products. My apologies to all of the manufacturers who have products languishing in the TtW! cue. We are changing things as quickly as we can. We are establishing a 24 VDC system so we can test 24 VDC gear. We are rewiring all of our PV modules (over sixty of them) so that we have arrays of various capabilities and can test various charge controllers. We will have both lead-acid and alkaline batteries available so we can test a wider variety of equipment. We are doing all this extra work just so we can effectively do the TtW! testing. We receive no compensation from the government, manufacturers, or others, and this is just the way we want it. We are a small crew with limited resources. We are doing what we can as quickly as we can.

On the subject of the LVD used in the Jade Mtn. LED light, the one in our test unit worked. Please realize that every RE system and operating environment is different. We have tested gear here which has failed, while others are using it with great success. In this case, the gear worked here, but evidently failed in other places. This is what makes TtW! testing so difficult and time consuming. No matter how hard we beat a product up, only time and operation in many systems will really prove the reliability and longevity of any given product. Richard Perez

Apathy
I am an avid reader of your magazine and have been for a number of years. As I see it, one of the main problems that the world faces is apathy and a lack of education in the areas of renewable energy and sustainable cohabitation with our environment. Education, implementation, and responsible use of our technologies will be the key to quality survival in the coming millennium. Keep up the good work, and thank you for being a major contributor in solving some of the worlds' ills. Rock Savage, ecorock@yahoo.com, Montpelier, Vermont

Hey, Rick, I agree! That's why we are giving away HP *for free on the Internet. Richard Perez*

Outrageous KISS
I subscribe to maybe two dozen magazines and newsletters. Every time *Home Power* arrives, it goes right to the front of my reading pile. What's more, very often I find myself reading Kathleen's Home & Heart first. Need I say more in response to the rude "KISS" letter in #64? Steen Hansen, CCP, hansen+@osu.edu

Another KISS
In response to the letter (KISS) from the North Bay, California resident in *HP* #64, pg 102, I feel compelled to come to Kathleen's defense. The regular feature in *Home Power* that I look forward to most is your Home & Heart column. As I read your monthly chronicle, clear and vivid images form in my mind. I never have a problem understanding your meaning. I read your column effortlessly. This is my measure of good writing. I am sure we all have had to read something over two or three times to understand its meaning. You do an excellent job each issue, and should be congratulated. Lane & Deborah Robinson, Winnipeg, Canada

Staber Washers
When I first started our new washer, I thought it was full of water. Unfortunately, it wasn't. I called the company and asked for the service department. I was connected directly to Mr. Staber.

It turned out that when the washer was modified locally to meet a rebate requirement, a couple of wires were crossed. I was walked through the diagnosis and repair over the phone. During our conversation, I mentioned we were using inverters. Mr. Staber said there was a better power supply board now and that he would send us one, although the one installed would work perfectly well. New boards are normally $150. The washer is not cheap, but we are still on our first large box of soap after 18 months, and I can't say enough about the service. wood@notes.osisoft.com

Need Water Heater Help
I am requesting your help in locating the supplier for a propane

instantaneous water heater to get replacement parts. The maker is from Germany, however, the German embassy could not locate the supplier for me. My last resort is your magazine with its large international readership.This is the information: JOH.VALLIANT GMBH U.CO REMSCHEID, FAB.85 19369183, MAG 125/7 TZ B, OUTPUT 8.7KW, INPUT 11.7KW

There are approximately 30 mid-size solar installations on the island which this company services and supplies equipment to, and some really great stories. I wish I had the time to share with other readers. My friends and I have been reading this great magazine for about four years now, and it has been a great help to us alternative energy users. Please keep on doing a great job. I can be reached at the email address below.

I bought a switch with an indicator light at a Sears store recently to enable my mother to see where the light switch was and found that it was a great way to tell when the inverter was in the sleep mode from the comfort of my bed. I figure some readers would find this useful. Peter Baugh, Jamaica • acemvill@cwjamaica.com

Automatic Control Engineering Limited, Mandeville Branch Office, 31 Decarteret Road, PO Box 208, Mandeville, Jamaica • (V) 876.962.2773 • (F) 876.962.3731 • (E) acemvill@toj.com

Hello, Peter. Let's see if one of our readers can help you find parts for that water heater. The light switch is a great idea. The light flashes when the inverter is asleep and is fully illuminated when the inverter is awake and producing power. We noticed the same effect with the LED indicators on several switched plug strips we use here. Richard Perez

Efficiency & Net metering in Illinois
Hey to all the renewable energy people out there. I am am writing because I just got off the phone with Peter Norman (an environmental advocate) from whom I found that the energy efficiency and net metering bills (SB 1227 and 1228) in our state (Illinois) are being stalled in committee by Senator James "Pate" Philip (phone # 217-782-3840). This is about what I would expect. Illinois, from what I understand, has the most nuclear power plants and the worst polluting coal plants in the US.

Although I receive many publications, I was unaware of any renewable energy legislation going through in Illinois until I read Jeff Green's letter in *HP* #62. Jeff hooked me up with an environmental advocate, John Thompson. John gave me Peter Norman's number, who sent me enough information about the legislations to enable me to get people lobbying. John Thompson and I were able to visit the local legislators, only to find that they are very pro-coal (as are most Southern Illinois legislators). As I went around talking to people about RE and these bills, I was surprised to find out how many people were knowledgeable on the subject and very interested.

My main point in writing is to locate people to collectively discuss and work on RE in Illinois. In the two years I have lived near Carbondale in Southern Illinois, I have located three stand alone systems. I am sure there are more. I have found out that the people in this area seem to live either in Chicago or in Southern Illinois. The two are very divided and different so it is hard to coordinate with everybody on the north side of the state.

Please feel free to call or write me anytime. I am starved for communication about RE, *Home Power*, I-RENEW and the MREA, which gives my faith a boost that RE stuff is out there and happening. A J Beck, Alternative Transportation and Energy, 186 Gates Rd, Pomona, IL 62975-2506 • 618-893-4087

Very Reliable Power
You are still doing an excellent job after ten years. That kind of commitment is to be commended. I've been doing this alternative energy thing since 1972...and beginning to get the hang of it. We now have seven homes in our canyon using PV. None of us have ever had a "Power Failure". When I read of winter storms leaving thousands without power, I say: "They need to learn to do it right." Jerry Igo, Mosier, Oregon

Comfortable Camping
Home Power is a great magazine! With the help of articles in *HP*, I purchased two 75 Watt panels, took them on vacation with me and powered my campsite. I had the comforts of home in my tent—I ran a DSS satellite system, color TV, 2-way radio, computer, and lighting.

P.S. Hey Richard...I see you are a Ham operator—me too. Do you have a packet BBS? My call N6WZZ, packet address N6WZZ@nbyn, 73'sss

Hello N6WZZ. Yep, I'm a ham and so is most of the Home Power Crew. I don't do packet yet, but I'd love to get started. The only thing holding this up is time, or the fact that I don't have any to spare. Maybe if I were to retire.... Richard Perez N7BCR

Four Corners Alert
I hope that *HP* readers will be interested in one more misguided electric production idea proposed by our government:

A natural gas-fired power plant is to be built in Mojave County, Arizona. One of those involved is the Western Area Power Administration (a federal agency).

While natural gas may be relatively clean, it is not an unlimited resource. The massive amounts of natural gas which will be used to generate electricity will accelerate depletion of our natural gas reserves. Colorado residents have had four natural gas rate increases in the past two years. Could this be due to large new pipe lines headed to major users of the new power plants?

This area is perfect for solar electric production, with lots of year-round sun. Please write your elected officials who are responsible, it's our money and our future. J D Huff, Chargin' in the desert on free solar, Silt, Colorado

Wind Alternators
We have been living with a solar electric system for almost two years and enjoy it more every day. We are interested on getting in touch with anyone in the country who might be doing research with automotive alternators. We don't really need to supplement our system, but I would like to experiment with wind mills using 12 Volt units from vehicles which are very available and inexpensive. (Good used alternators here are $20 and many have built in regulators.) I got re-invigorated when I saw the story about Gaviotas on the cover of Chelsea Green's *The Junction* that just came in the mail.

Please let me know if you (or anyone you know) is doing anything using salvaged parts. Most of the books available are usually selling products, often beyond the reach of those just moving onto raw land.

I just located a 1966 12 Volt generator which was in a Volvo for only $25. It works fine, puts out 40 Amps at 1000 RPM, and 60 Amps at 2000 RPM. Which is better, and why: an old generator like that, or a newer alternator for use as a wind generator? The generator discharges at 500 RPM or less. Thanks for any help. Robert Lawrence, Fountain, Florida

Hello Robert, check out the book review on page 92 of this issue. This book has all the info you need to answer this question and many you probably haven't even thought of yet. Richard Perez

RE at Appalachian State U
We love your magazine. We are in the graduate program for Appropriate Technology at Appalachian State University in Boone, North Carolina. Your magazine is our primary resource in many of our classes due to its practical, easy-to-read nature and because of the variety of topics you cover. We would like to see an article addressing renewable energy education around the US in higher institutions of learning. Let us know if we can ever help you. Anne-Marie Suddreth, Vice-President, Appalachian State University Solar Energy Society, Boone, North Carolina

Hey, Anne-Marie, what a great idea! Let's do it. How about it, HP readers? If you are in a RE program, let us know what's up with it. If enough folks respond, we'll print the data as an article. Richard Perez

Disappointed Student
As a full -time student at Colorado State University, I am disappointed in the lack of interest concerning RE, regarding the community as a whole. Everybody seems to hint that it's a good idea, but few practice it. The solar plant and research facility is seldom in the spotlight, and the library doesn't even carry *Home Power*! Since finding *HP* on the internet, I've made it my personal mission to implement RE in all aspects of my life. Somewhere down the line, I'd like to be actively involved in helping spread the word about RE. I'll start with a subscription to *HP*, then on to the great southwest to build my solar dream. Worlds of Thanks. Robert Herb, Fort Collins, Colorado • rherb@verinet.com

Unconventional Education
I am wishing to pursue an unconventional education in green architecture. I have been discouraged by the lack of focus concerning sustainable building methods and alternative energy sources contained within many of the universities' accredited architecture programs. The few universities that do offer a more progressive curriculum are usually expensive and have a difficult acceptance rate to the program. I have just completed a Bachelor in Art degree at the University of Mississippi, and am not quite ready for a rigorous program on the Masters level in architecture anyway. However, it is a consideration for the future, especially if I am facing specific hardships and limitations due to not having an accredited degree. I also feel it might be advantageous for me to do this in reverse sequence. I would be able to apply what I had learned though unconventional channels and hands-on experience to my projects within an architectural program. This would create more interest and a higher learning capacity. I am interested in feedback.

I want to build my own home in New Mexico, completely off the grid, with respect to the environment and my health, and I would like to help others in the same endeavor. I hope to eventually gain enough knowledge so that I can be a consultant in the field of green architecture, i.e., straw-bale construction, earthship homes, rammed earth, passive solar electricity, wind power, greywater and whole water systems, water purification, composting toilets, air purification, natural lighting, utilizing recycled materials creating a non-toxic home, etc.

I am hoping you might have information on recommended schools for building, workshops, certification courses, and any other educational course concerning sustainable building and alternative energy. Any assistance that will help me in the pursuit of these dreams would be most appreciated.

I am just beginning to pursue what I perceive to be my path in life, and would like your opinion concerning converting my passion to reality. Thank you so much for your help. Laura Kephart, lkephart@dixie-net.com, University, Mississippi

Laura, when it comes to hands-on education in both RE and alternative construction techniques, the undisputed best source is Solar Energy International. See their ad in this issue. Also, be sure to check out the Happenings section in each issue. When it comes to architecture, ya got me, but one of our past Crew members, Ms. Therese Peffer, is now studying architecture at the University of Oregon and thinks they have a dynamite program. We really need to make a nationwide database of RE programs in schools and universities. How about it, HP readers—any takers? Richard Perez

SolWest Renewable Energies Fair 1999
It's been too long since we had a really good energy fair on the west coast! The first annual SolWest Renewable Energies Fair will happen at the Grant County Fairgrounds in John Day, OR on the weekend of July 24-25, 1999. It will be a 2-day extravaganza of displays (by RE manufacturers and dealer-installers), workshops (on diverse topics related to RE and energy conservation), demonstrations, and events such as a ZEV and LEV road rally and hillclimb. Our intention is to immerse visitors in the RE experience and create enthusiasm, teach practical techniques, and show new products.

John Day is located on the "sunny slope" of the west coast, on the east side of the Cascades. The city has only 9 fewer sunny days per year than Phoenix, AZ, so July sunshine is nearly guaranteed! Access is easy, via scenic, uncrowded 2-lane US highways. There is unlimited free camping within 20 miles, as well as RV parks and motels in town and onsite camping at the fair.

We will have a website soon with a map, photo, and more info. Suggestions, comments, and volunteers welcome. If you would like to be on the mailing list for SolWest information, please forward your name and address (email preferred, but snail mail also welcomed!) to: SolWest, c/o Jennifer Barker, HC 84 Box 632, Canyon City, OR 97820 • 541-542-2525 • E-Mail: solwest@eoni.com

Yeah! Renewable Energy Fairs are crucial to the twin processes of education and awareness. Organizing the Arcata REF this year was a real eye-opener. Putting one together is an unbelievable amount of work, but I can't stress how important they are. Although at times discouraging, I can honestly say that it was one of the best things I've ever done, and the day of the fair was one of the highlights of my life. Anyone interested in helping out—please become involved. You won't regret it! We will definitely see you in John Day in 1999! Joy Anderson for the HP Crew

Utilities
I am writing to you with accolades, an article FYI and a few questions. I enjoy the magazine very much. It represents good and varied ideas, is a good platform to showcase new methods and debates, and presents the practical application of theoretical ideas. I like all of the material presented because I truly believe that renewable energy is the way to go.

I came across an article which presents what I believe to be a common view point that I can use to introduce my questions. The article was a guest column in the December 18, 1997 edition of the Wisconsin State Journal (a Madison newspaper). The article describes the installation of a wind energy plant by one of the local utilities, Madison Gas and Electric (MG&E). The author praises the work of the utilities and states that consumers should like the idea of a wind energy plant and buy the power it produces, even if the wind energy electric rate is higher than normal, non-wind energy generated electric rates. The author laments that other utilities do not offer options of renewably produced electricity to their customers, and would like to see the government step in to help solve the problem. One stated solution would have the government require the utilities to produce more environmentally friendly power. The other stated solutions would have current laws amended so consumers could choose from whom they purchase their power, based (among other things) on their like or dislike of the power production method.

I have heard this type of argument before, and I wonder if it is commonplace. I think the article is good because it discusses alternative energy production and purchasing methods, but what I don't like is that the author immediately consents to pay a higher unit rate for the environmentally friendly energy. Certainly, MG&E likes that thinking. The article touches on the fact that some utilities may be more market driven or progressive than others, but it advocates the involvement of government to force utilities into renewable energy. I'm not so sure that many utilities pursue alternative energy production methods because they have sustainable, altruistic views for the future. However, if external reasons cause them to seek, install, and use less polluting energy production methods, it's a positive step, but I am not happy that the government was mentioned as the only solution to the problem.

So, what's my point? Well, I have an intuitive feeling that the author's perception is not correct. At least concerning the idea that alternative energy must cost more than fossil fuel produced energy. However, I don't have the understanding of utility subsidies, governmental energy policies (historical, present, and future), future utility goals, and of the energy business in general that would allow me to argue effectively against the author's point of view. Through my education

and training, I am beginning to understand the technical fundamentals of alternative energy production. However, I have no education as to why the current energy policies exist the way they do, or why utilities operate the way they do. I certainly do not understand why people think that expending a bit more effort to be clever, fostering the use of non-polluting methods of energy production and living, is loathsome and that all renewable energy is and will always be costly. My gut tells me that the extra expense should be incurred in our heads, not doled out from our pockets, but I can't form clear rational reasons from my gut. I need facts, figures, insights, histories, etc. Please help if you can. Where can I find such references, books, journals and information? Godspeed!

P.S. As an environmental engineer, I come face to face with costs associated with pollution remediation—it can be an enormous sum. I am all for the unit price of hydrocarbon energy increasing to reflect this and other embedded, but unfunded costs. I am trying to learn how correct policies benefit the hydrocarbon industry (if this is true) at the expense of other forms of energy. Paul Greeman, Madison, Wisconsin

Well, Paul, the American Solar Energy Society (ASES) did some research during 1989 and came up with the following hidden energy costs.

Hidden Energy Costs in the USA (ASES 1989)

Hidden Cost Classification	Minimum in Billion $ per Year	Maximum in Billion $ per Year	Average in Billion $ per Year	Hidden Cost per US person in $ per Year
Subsidies	$43.3	$55.2	$49.3	$197
Health Impact	$11.8	$82.0	$46.9	$188
Military	$14.6	$54.0	$34.3	$137
Employment	$30.6	$30.6	$30.6	$122
Radioactive Waste	$4.3	$31.2	$17.8	$71
Crop Loss	$2.5	$7.5	$5.0	$20
Corrosion	$2.0	$2.0	$2.0	$8
Totals	$109.1	$262.5	$185.8	$743

While this info is surely out of date, it does show the magnitude of the problem. I'd like to quote Michael Nicklas in the ASES report where he states, "Our free market economy operates best when both the buyer and the seller have complete knowledge of which choice will benefit them the most. With energy, this is obviously not the case. How many people know that sulfur dioxide from just our coal burning plants is costing Americans $82 billion per year in additional health costs? How many farmers are aware that they are annually losing $7.5 billion per year due to reduced crop yields caused by air pollution? And, how many people are really aware that nuclear waste and decommissioning costs (which, for the most part, we have not seen yet) are the equivalent of $31 billion per year?"

Here are some things we each can do on our own, without help from the government or cooperation from the utilities. Conservation can be practiced by everyone. Whether you make your own power or buy it from the grid, conservation saves energy. Implement conservation techniques in your home. Install efficient lighting. Turn off unused appliances. Find and isolate those "phantom loads". When you buy an appliance, make efficiency your prime criteria. If each of us practices conservation, then I estimate we could reduce America's electric bill by half. And this means not only half of the money spent, but half of the environmental damage. Conservation offers immediate, short term relief until we can mass-implement non-polluting renewable energy sources.

Perhaps the best thing any of us can do as individuals is to actually use renewable energy sources. And the best place to start is at home. *See page 106 for a discussion on guerrilla solar.* *Every time any one of us puts up a PV panel, a hydro turbine, or a wind generator we are directly helping solve America's energy problems. Every time a renewable energy source is used, then power that would have been produced by combustion or nuclear reaction is instead made by clean renewable methods. It's not often we get a real chance to change this world and stay at home at the same time. Put up a PV panel, harness that creek, put that wind machine up! Richard Perez*

Pro Utilities

I read your magazine from an engineering perspective. But I also have to say I notice the tone. Utilities are not malevolent—they are staffed by regular people. I like their convenient service and so do most people that I know. I believe that spreading a positive message, positive in ALL respects, will be far more effective. Remember, in a relatively "free" market, monopolistic utilities exist at the pleasure of our elected representatives. Unfortunately, this distorts them into centralized, bureaucratic behemoths that can't change. They sort of prove that government has no business in business! Charlie Bright, Ames, Iowa

Charlie, I realize that utilities are staffed by folks just like us, not ogres or monsters. My brother has been employed by the San Antonio, Texas municipal utility for almost twenty years now. I know he's not a malevolent person. The problem is not the rank and file utility folks who do the actual day-to-day work of getting power to millions of homes. The problem is in the upper level management. They are quite content with the status quo. This means burning coal without regard to its pollution. This means more nukes without a clue of what to do with their leftovers. This attitude of "damn the environment and profits as usual" has made me an enemy of the utilities' management, not their workers. Yes, these utilities "exist at the pleasure of our elected representatives" and everyone knows that we have the best elected representatives that money can buy. And buy them is just what the utilities do. It's time to take power out of the hands of businesses which operate strictly for a profit, with no regard for sustainability and our environment. It's time to put the power on our roofs, where WE can control it.... Richard Perez

Just an armchair, younger, upwardly mobile type with an opinion

I would like to preface this by saying that I love *HP* magazine and the information therein. I have been reading *HP* for ~2 years now. I anxiously await the day when I will be able to put your systems articles to use. At present, I am not technically nor financially able to utilize these resources, so they stay tucked away in that that corner of my brain that yearns for exercise. (I suppose I would be considered one of your "armchair" readers, as Ron Macleod expressed in #64.) In the meantime, I relish the back part of your magazine—letters, notes, IPP, the more "subjective" sections.

I would estimate my heart has ~7 years invested in conservation and RE. When I found your magazine, I immediately felt connected to these unknown faces and entities who are either devoting their lives to RE or integrating it into their own passion. There is, however, a recurring tone which permeates the pages of *HP*, and turns me off considerably. At first, I ignored it. Then I questioned what was wrong with my thinking, assuming you knew what you were talking about. Now, I would just like some answers.

You state that your magazine is not intended as a political or ideological forum. Yet, at every possible opening, you find a means of "sticking" The Utility, The Industry, The Government—THEM. If you don't do it, you let your readers do it. "The sharks gather. As long as we put our future in the hands of those who want to rent us sunshine, we deserve what we get..." (Please realize, I am not arguing your position here, just your point.). This idea that the electric utility industry is some dark and looming evil presence that controls us and burdens our sovereignty results in a mental image of helpless flailing tiny people screaming as they get squashed under a big thumb. It becomes almost humorous. From many respects, I would probably agree with you. I do see the inherent problems with utility

involvement/control of solar. There are things about utilities that "I wouldn't do if I were the one doing it." But something I would like to reconsider is the "Us", in this "Us vs. Them" scenario that keeps being represented in those latter pages of *HP*.

I work for a utility contractor providing residential energy audits. I'm either in the homes, on the phone, or reading the satisfaction surveys of these utility customers who are provided a free educational service regarding their energy consumption. I don't know all of the details of how it happened, but somewhere along the way, the average end-user has come to expect electricity, as if it were a God-given right. Yes, maybe the utilities have fostered that perception. Or, more accurately, the powers which have created the utility. Here in the Midwest, our electricity is cheap (note: I refer to the end-user cost, not costs associated with production, transportation, generation, etc.). People get angry when faced with the reality that there is a cost associated with their energy use. They get even angrier when this cost conflicts with their comfort levels. They often have no concept of why they should do anything at all to conserve unless it directly and immediately lowers their bills and in no way jeopardizes or alters their comfort. I remember Andy Rooney making a comment about Americans: If given a sack of grain, they would probably just use it as a pillow. I get the same impression with energy use. People are so disconnected from the reality of energy that they have no concept of their true role in the realm, its production or consumption. That said, I would be more apt to apply the attitude you have of utilities to the average American. It is they who are the THEM to me. It is the average American that pushes me against a brick wall, not the average utility employee. But you can't do that. Attacking the utility is safe. They don't have a name, or a face. You can't attack the customer, because they are your customers. Who would do that? It's suicide.

The utility is what people know, right or wrong, for better or worse. And it is the utility who has the best opportunity to reach these people. I ask you an honest question: What is inherently wrong with utility involvement in PV, if the end result is getting PV out there and getting a more educated consumer? I'm not asking for details, and particular worst-case scenarios. Just the idea. Like anyone else, I want to do the right thing. Aside from all the "bad stuff" associated with utilities, I must admit, I see them as a prime vehicle for getting the needed technology and education to a large number of people. I think PV in the boonies is great. Someday I'll be there. But today, I'm not there. And today, some 250 million Americans aren't there. Do I want the utility to have complete charge and control over this education and development? Of course not. It isn't their job. It isn't what they know. It's yours. But I know the bottom line: the utility is going there, with or without you. If this attitude of non-cooperation with utilities is fostered, they'll go there without you. I, for one, would much rather see them go with you, lest we end up with another bunch of crap systems and once again impress upon our public at large...Solar? Oh, you mean that old yellow thing on my roof that doesn't work?

I don't want you to change who you are, what you do, or what you stand for. I would just encourage you not to foster this attitude that the utility is inherently evil, and "get off the grid." Regular people can't just do that. You are seeing a change in your audience (i.e. towards the armchair reader). But they haven't changed. The only change is that now they are reading your magazine, which is a good thing. I hope you don't allow yourselves to get frustrated or bogged down if an influx of slightly "less radical" opinions were to flood in your direction. Show them, by example, by a right attitude, and a right end-result. As I see it, the end result is more electrons generated by infinite resources than by finite ones.

You have "Code Corner" and "Wrench Realties." I think they're great! Ever consider a "Voices from the Field...and from the Office" exchange? Leslie Cockburn, P.O. Box 43233, Cincinnati, OH 45243 • E-Mail: lcockburn@Cinergy.com

Hello, Leslie. I have tried making allies of the utilities. Lord knows, I have tried. Utilities are only interested in power sources they can own and control. RE is freely offered to all of us by nature. These concepts don't mix. We've seen, over the last ten years, the utilities progress in RE production and education. The large scale RE projects undertaken by utilities have been miserable failures. For example, the Carrizo Plains and Hysperia PV utility projects. These projects fail because they are designed to fail. When it comes to education, what we get from utilities is, "RE is not cost effective or practical." And this is true, from their perspective. A power source which is free is not practical—they can't sell it to us for a profit when we can do it for ourselves less expensively. If you are pinning your RE hopes and dreams on the utilities, then you are going to be disappointed.

In terms of people taking electricity for granted and expecting it for free, you won't find this attitude among most Home Power *readers. We know what a kWh is, we know how to make it and how to efficiently use it. We know what we paid for our systems. While the energy is freely offered by nature, the RE hardware costs money. I dare say that you will not find any group who is more realistic about energy than* HP *readers. Their hearts are in the right place—they are making their power in a sustainable and ecologically sound manner. I will not attack our readers. Instead, they deserve some praise. Good work, folks, and keep it up! Richard Perez*

Questions and Comments

Let me start by saying I enjoy the mag a lot and have picked up some issues from #48 on up, but I only recently started getting a subscription. At any rate, this mag is the only one I read from cover to cover and still want more information. Enough about my reading and purchase habits. Here are my questions: every one, except for me, seems to know which appliances are the most efficient (as far as power use goes). I am hoping that someone has a list of the most efficient equipment that I can get my hands on. Also, I'd like to comment about the cost of your web server download.

I don't know if you quickly thought and rejected the idea of advertising on the web with those types of ads that you see on the search engines and other sites. These could be related to your site in some way. At any rate, this is the first and probably not the last note to you and your staff. Thanks for the great mag. Eric Smith: esmith@aoc.gov

Welcome aboard, Eric! We'll get started on a database of efficient appliances for RE systems. In terms of regular appliances used in homes, there is already a great book called Consumer Guide to Home Energy Savings (ISBN 0-918249-21-X). It is published by the American Council for an Energy-Efficient Economy and costs only $7.95. See Ozonal Notes in this issue about our web site and keeping the download of HP *for free. Richard Perez*

Writing for *Home Power Magazine*

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your RE experiences printed in *Home Power*.

Informational Content
Please include all the details! Be specific! We are more interested in specific information than in general information. Write from your direct experience—*Home Power* is hands-on! Articles must be detailed enough so that our readers can actually use the information.

Article Style and Length
Home Power articles can be between 350 and 5,000 words. Length depends on what you have to say. Say it in as few words as possible. We prefer simple declarative sentences which are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in *Home Power*. After you've studied a few, you will get the feeling of our style. System articles must contain a schematic drawing showing all wiring, a load table, and a cost table. Please send a double spaced, typewritten or printed copy if possible. If not, please print.

Written Release
If you are writing about someone else's system or project, we require a written release from the owner or other principal before we can consider printing the article. This will help us respect the privacy rights of individuals.

Editing
We reserve the right to edit all articles for accuracy, length, content, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get published first.

Photographs
We can work from any photographic print, slide, or negative. We prefer 4 by 6 inch color prints without fingerprints or scratches. Do not write on the back of your photographs. Please provide a caption and photo credit for each photo.

Line Art
We can work from your camera-ready art. We can scan your art into our computers.

We can redraw your art in our computer. We usually redraw art from the author's rough sketches. If you wish to submit a computer file of a schematic or other line art, please call or E-mail us first.

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Send us your article's text on 3.5 inch computer floppy diskette, either Mac or IBM format. We can also read ZIP disks (either Mac or IBM), and Magneto-Optical disks (128 MB, 230 MB, 1.2 GB and 1.3 GB all Mac only). This not only saves time, but also reduces typos. Please also send a hard copy printout of your article. Save all word processor files in "TEXT" or "ASCII TEXT" format. This means removing all word processor formatting and graphics. Use your "Save As Text" option from within your word processor. Please don't just rename the file as "text" because it will still include unreadable (at least to us) word processor formatting.

You can send your article via modem either to the *Home Power* BBS at 707-822-8640 or via Internet, as an enclosed ASCII TEXT file. On the BBS, address the message with the enclosed file to "Richard Perez". The E-Mail address is: richard.perez@homepower.org. If you are sending graphics, or articles with embedded graphics, then use this special E-Mail address: rap@snowcrest.net

It is wise to telephone or E-mail ahead of electronic file submission. This is particularly true concerning graphics files. There are many, many, many ducks and they all need to be in a row....

Any questions?
Give us a call and ask. This saves everyone's time.

Access
Richard Perez, c/o *Home Power Magazine*, PO Box 520, Ashland, OR 97520 USA • Voice Telephone: 916-475-3179 (during West Coast USA business hours, otherwise you will get an answering machine)• FAX: 916-475-0836 (24 hours a day)• Internet E-Mail: richard.perez@homepower.org

Ozonal Notes

Richard Perez

Guerrilla Solar!

Technology has a way of getting ahead of society's ability to cope with it. While looking at the new Trace microsine inverters (see the ad on page 41), I was struck with the opportunities they offer for guerrilla solar power.

The microsine inverter works on the back of one or two PV modules. It is a synchronous inverter designed to work on-grid. It gets into phase with the utility power and pushes energy either into your appliances or onto the utility grid. The entire system is very easily assembled, inexpensive, and uses no batteries. Just wire up the modules and inverter, and then plug the inverter's output into any 117 vac receptacle on your wall. If the sun is shining, then the PV energy is being fed into your household. If the sun is shining and your house is not using any power (this happens often during the day in most homes), then the PV energy goes to the grid.

This new technology allows anyone to instantly have a utility-intertied PV system. It also provides de facto unlimited net metering for the PV energy placed on grid. In fact, the whole process can be accomplished without ever talking with the utility, and without regard for state laws regulating RE—guerrilla solar power.

What is stopping the development of renewable energy? Is it technology? Economics? No, the underlying reasons are politics and greed.

While we fight in the nation's legislatures to implement net metering for RE systems, to eliminate needless "safety" equipment and mega-bucks insurance, here comes a nifty gizmo which makes all this technically unnecessary. Just wire it up, plug it in, and you have effectively bypassed all the legal nonsense and utility weaseling. Unless you have a lot of solar power, the only thing the utility may even notice is a reduction in your electric bill.

Now, is this legal? Well, probably not. Far be it for me to recommend that anyone do anything illegal. However, widespread guerrilla solar is a very real possibility. Technology and how we could utilize it has once again outdistanced our legal and business establishments.

The Second Front

Although we will continue the struggle in the nation's legislatures and courts, we could now open up a second front in the Renewable Energy Wars. The battles in this second front will not be fought by politicians, lawyers, activists and judges; but by every day folks just letting a little sunshine into their lives. The guerrillas in this struggle are guaranteed to win every battle—the utility doesn't even know that the battle took place until they have already lost it. I know of one guerrilla solar system which is already up and operating in PG&E's territory in California. Soon, I expect to see guerrilla solar systems springing up all over the country.

Why would someone wish to setup a guerrilla solar system? Well, with the utilities jealously guarding their monopoly to pick our pockets and pollute our planet, we can just go around them rather than engaging them in a series of long and difficult battles. This is the essence of the guerrilla. Fight the battles you can win, and go around the ones you can't. Guerrilla solar instantly gives us what we are laboriously fighting for in the legal arena. It takes this whole energy question out of the control of utilities and politicians and places the decision in our hands.

Solar energy has radically altered our lives. These changes are unavoidable and will continue. For over one hundred years, the utilities have been making three things: energy, profit, and environmental messes. Right now, technology and plain ol' sunshine can place clean electric power generation on any roof. *Your* roof.

Proposed Oregon Net Metering Law

As solar power activists, we are formulating a net metering law to be submitted to the Oregon Legislature. The coalition proposing this bill includes the Oregon Solar Energy Industries Association (ORSEIA), the Solar Energy Association of Oregon (SEAofO), the American Wind Energy Association (AWEA), Bergey Windpower, *Home Power*, and many others. Here is a list of the four points up for discussion on this bill:

• Net metering to parity for all utility-connected RE systems in Oregon. This bill will cover all RE resources—solar, wind, and microhydro—not just solar, as most state net metering bills do now.

• The maximum allowable size of a system covered under this bill will be 25 kiloWatts. Note: specified is power (in kW), not energy (in kWh).

• The law will require only a single kWh meter, no useless and expensive "safety" equipment, and sensible, affordable insurance requirements. Net metering will be zeroed out on a yearly basis.

• If the RE system shows a surplus at the year's end, then this energy will be donated by the RE producer, on a one kWh to one kWh basis, to a utility customer who is in a low-income, utility assistance program.

This proposed net metering bill will be one of the strongest in the nation. The donation of our surplus RE

to low income families is a major goal for us. Instead of giving our surplus power (the finest and greenest kind) to the utility for free and allowing them to resell it to others for a profit, as is common in all other net metering bills, we wish to donate our surplus RE to the people who need it the most.

As RE producers, we hate to see our energy go to waste. I know that when our systems' batteries are full, when we've already pumped all the water we can hold, when we've done all the clothes washing we can do, and when I can't think of what to do with the surplus, I get sad. I feel that the only thing worse than not being able to effectively use all our RE on site is giving it to a utility for free.

We've always said that we want to share our energy with our neighbors. Well, here's our chance.

Low income plans for utility customers already exist within our current system. We could donate our surplus RE to these customers on a 1 kWh to 1 kWh basis. This is effectively having our surplus RE valued at retail rate. We may not get a check from the utility, but at least our renewable energy is valued at a fair rate and going to someone who could use it.

From the perspective of the legislators, this is a beneficial move—poor folks vote too. From the viewpoint of the poor folks, this is a good program because their electric bill may go down a smidgeon. As seen by the utility, this is a public relations nightmare. While it gives us net billing beyond yearly parity, it puts the utility in a very negative PR position if they object. After all, if we can give the finest kind and most expensive type of energy away without expecting compensation, than the least the utility can do is transmit and distribute it for free.

I don't see anyone objecting to this, save the utilities, and I don't think they would dare.

Consider the advantages that RE producers bring to the utility. Since most systems are solar, our systems produce a surplus virtually every day during daylight hours. At this time, often no-one is home using energy, and the PV arrays are producing power. This gives the utility this solar energy on peak when they need it the most, and when they value it the most. When RE producers withdraw energy from the grid, it is commonly at night when the utility has an energy surplus. Therefore, this energy is considered to be less valuable to the utilities. Take a look at utilities offering time of day metering schemes and you will see how they value on-peak and off-peak energy. In most cases, the off-peak rate is just a penny or two above avoided generating cost, while the on-peak rate is six to ten times the off-peak rate.

If this proposed net metering bill is to succeed, then we need the support and input of all the RE people in the state of Oregon and even beyond. We want this bill to give you what you want. If we are going to fight the utilities with all our might, then let's make this battle meaningful. Please see the Access section at the end of this article to find out how you can become involved with Oregon's proposed net metering bill. We can use all the help we can get. We are fighting this battle on the utilities' turf. They have substantial money and influence—all we have is foresight and determination.

If we can't convince our legislators, if we can't pry open the utilities' death grip on electricity, and If we fail at our attempt to implement net metering in Oregon, then remember guerrilla solar power. And don't forget—there is always the option of going off-grid entirely.

Home Power on the Internet

Well, we've been reading the mail you have been sending to us. The major question is, "What should *Home Power* charge for downloading an issue form the Internet?" Almost all the responses say that you wish us to keep the downloading free. That's just what we're going to do.

We have moved our big downloadable files to another web site which is far less expensive. To finance this continued free distribution, we are going to ask the advertisers in *Home Power* to pay a little extra to get their ads published in the electronic edition. This small charge to the advertiser is compensated for by the greatly increased exposure they will receive. The circulation of the electronic edition is now twice the circulation of the paper addition. I estimate that every edition of *Home Power* is now being read by around 100,000 people.

You can download the latest *Home Power* by going to www.homepower.com with your favorite web browser. You will need Acrobat Reader, version 3.0 or better. It's available free through a link on our web site. The latest issue of *Home Power* is about 6 MB in PDF. Most folks report download times lasting about one hour.

Access

Author: Richard Perez, c/o *Home Power*, PO Box 520, Ashland, OR 97520 • 530-475-3179 • Fax: 530-475-0836 • E-Mail: richard.perez@homepower.com
Web: www.homepower.com

Written on 1 May 1998 at Funky Mountain Institute (42°01'02"N • 122°23'19"W) using solar & wind power.

Oregon net metering bill: Richard Perez (see above) or Oregon Solar Energy Industries Association, David Parker, President, 399 East 10th Avenue, Eugene, OR 97401 • 541-302-6808 • FAX: 541-302-6810
E-Mail: esco@efn.org

Q&A

RE: Q&A, HP #59, Cell Rotation

I have seen the early demise of the "outside cell" a few times, and usually the culprits are slightly undersized battery cables. It works like this: after a sustained heavy discharge (or charge) the cables have warmed a little. The battery terminal conducts this heat down to the plate, which warms the electrolyte. This cell (or cells) now has a tendency to overcharge a little, causing excessive oxidation of the positive plate. This sets the scene for premature failure of the outside cells, albeit after considerable use.

This scenario can still happen with adequate cable size, and identical cable used for cell-to-cell (or battery to battery) connections. The first item in the battery cable (the fuse, brake, etc.) can be warmed in normal charge/discharge situations, and the nice fat cable with its excellent electrical and heat conduction properties will again warm the outside cell(s). You can see why only the cell at the positive end of the bank may be affected—on which polarity are the protection devices installed?

Careful monitoring of cell temperature will identify the situation. If all cables are sized properly, the best solution is cell rotation at regular intervals. Incidentally—ever noticed that the end cell(s) on a relatively new battery bank have the highest specific gravity? Dave Jamieson, Paekakariki, New Zealand

Hello, Dave. If the battery cables are getting hot, then they are **way** *too small in diameter. Battery cables should be made from 0 to 0000 gauge copper cable. The amount of sustained current it takes to warm up such a short, fat cable is hundreds of amperes for many minutes. Most systems never do this. Fuses and disconnects are located in the positive leg, but are usually far from the battery.*

So many of us have noticed that the outside cells in a battery fail first that there must be something going on here. I think we have yet to firmly identify and quantify the failure mechanism.

This is quite possibly one of those irritating "combination of ingredients" problems. Mr. Surrette Sr. of Surrette Battery thinks that the outside cells fail first because the conductive acid smaze on top of the battery can and will conduct current between the cells (self-discharge). This is why his batteries have double cases which keep the tops and terminals clean and dry. I think that the outside cells fail first because of the electrical nature of a battery—each battery is a collection of cells and each cell has both resistance and capacitance (in a classical electronic sense). When you make a series/parallel arrangement of this R/C network, then the outside cells work harder during the high frequency, high current surges which occur when inverters and motors are powered by the battery.

You and others have suggested that the outside cell failure is thermally related, either by heat from the cables, or heat from the ambient environment. What is the real cause? Stay tuned...who knows, we may just figure out what is really going on. I rarely use a hydrometer but rely instead on a battery Ampere-hour meter, so I haven't noticed that the outside cells in new batteries have higher specific gravity than interior cells. How about it, readers? Are you finding that the outside cells in a battery fail first? Has anyone got an idea of why this happens? Again, until we figure this out, the best course of action is yearly rotation of cells/batteries. Richard Perez

900 MHz Cordless phones

I would like information regarding research that has been done on 900 MHz telephones. My idea is to put a solar panel & battery on a phone pole with the base/recharging unit, battery and inverter in a weather proof box. The handset would be at my house with an additional base/recharging unit to recharge the batteries in the hand phone. Distance from house to pole (where the phone line connects) is approximately 2500 feet.

Can't put the phone underground (too much rock), can't go overhead (unable to obtain easement), and the existing wire laying on the ground gets eaten by rats, bulldozed, burned, mowed, weed-eaten, etc.

Probably the most important factor in my installation is range of the signal. Also, 12 Volt (i.e., the wall cube) is preferable, so I don't have to invert, convert, divert or revert to something else, making me a prevert. Chaz, Hawaii

Hey, Chaz. To the best of my knowledge, there is no book or set of instructions to help you hot-rod that 900 MHz cordless phone. First off, the process is illegal as it violates an FCC regulation which prohibits modification of all cordless phones. This regulation is in place so that these phones will work and not interfere with each other in urban areas. If you live in the sparsely populated country, then interference should not be a problem. Having said this, here's what I have learned by fooling around with these phones.

You must use only one base unit (the one that came with the phone). You cannot have a second base for recharging the handset at your remote location. Each base is encoded to a specific handset. Using two bases will hopelessly confuse the entire system.

This distance you mention is about 1/2 mile and this is easily done with slight antenna modification(s). Antenna modification means removing the small vertical whip antenna on the base unit and replacing it with a multiple element gain antenna such as a Yagi. Making this Yagi beam antenna will be a homebrew project because you can't buy them ready made at this frequency. Ideally, you should also modify the impedance matching network between the base unit and the Yagi. The RF output amplifier of the base unit is matched to the small vertical whip antenna (which was removed). This whip has a characteristic impedance of around 20Ω or less. The Yagi and it's coaxial feedline will have an impedance of around 50Ω. Tweaking the matching network will deliver more transmit power to the Yagi. Since the handset is tied down to a set of power wires anyway, there is no reason not to also replace its whip antenna with another coax fed Yagi. You should also modify the matching network on the handset for this new antenna. If you modify both antennas, then a standard cordless will talk over several miles if there is line of sight between the two antennas.

After you have tackled the phone connection, the next problem is electric power to run both ends of the system. On the base end, most of the cordless phones are using a 12 VDC wall cube which takes 117 vac grid power. The wall cube turns it into 12 VDC to run the base and recharge the handset. Just eliminate the wall cube and replace it with a PV re-charged 12 VDC battery. Be careful to get the polarity right, or you will fry the base unit. Also, the battery for the base can be very small if you don't spend a lot of time on the phone. Consider a 6–10 Ampere-hour, 12 VDC, sealed, lead-acid, gel cell battery fed by a small PV such as the Solarex MSX Lite 5 Watt module. Even though this is a micro PV system, you will need to regulate the module so it does not overcharge the battery. On the handset end, just replace the 4.8–6 VDC battery inside the phone with wires which run to a DC/DC supply powered by your main RE system battery. Both the PV regulator for the base end and the DC/DC supply for the handset end are easy homebrews. For the schematics, see HP *#40, p.105 and* HP *#29, p.69.*

The only remaining problem is that the newer cordless telephones use a channel hopping scheme which allows the phone to automatically jump around in frequency to avoid interference from other cordless phone signals. The handset can become out of sync with the base on occasion. In normal service, this is not a problem, because the handset gets into sync every time it is returned to the base even for just a moment. In your case, the handset will never get back to the base unit. If the handset becomes confused, you may have to put the battery back into the handset, walk over to the base, and insert the handset into the base unit. Check out the cordless phone you buy: the less expensive models do not have the automatic channel hopping feature and are better candidates for hot-rodding.

While all this seems like a lot of work (and it really is), hot-rodding a cordless is far cheaper than buying and licensing a real radiotelephone. See HP *#56 pages 42–48 and pages 50-54 for a discussion of radio and radiotelephones. The modifications here are not difficult, but do require some radio, electronic, and fabrication skills. Before you jump into that new $200 cordless phone, make sure your tech is up to the job. If you have doubts, then study up, experiment, and seek the help of a radio* electrificando *such as your neighborhood Ham radio op. Richard Perez*

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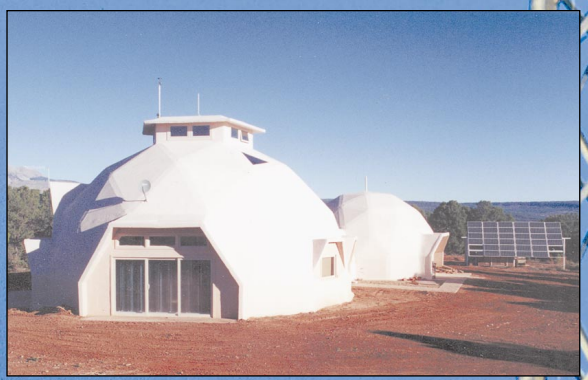

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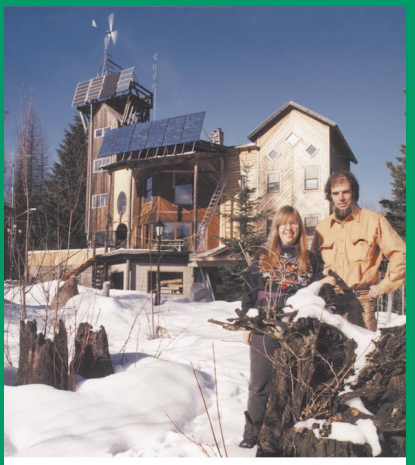

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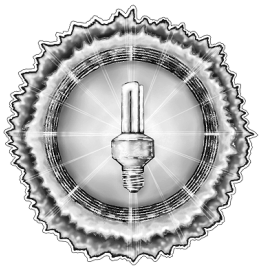

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